ENGINEERING NEWS-RECORD

October 10, 1940

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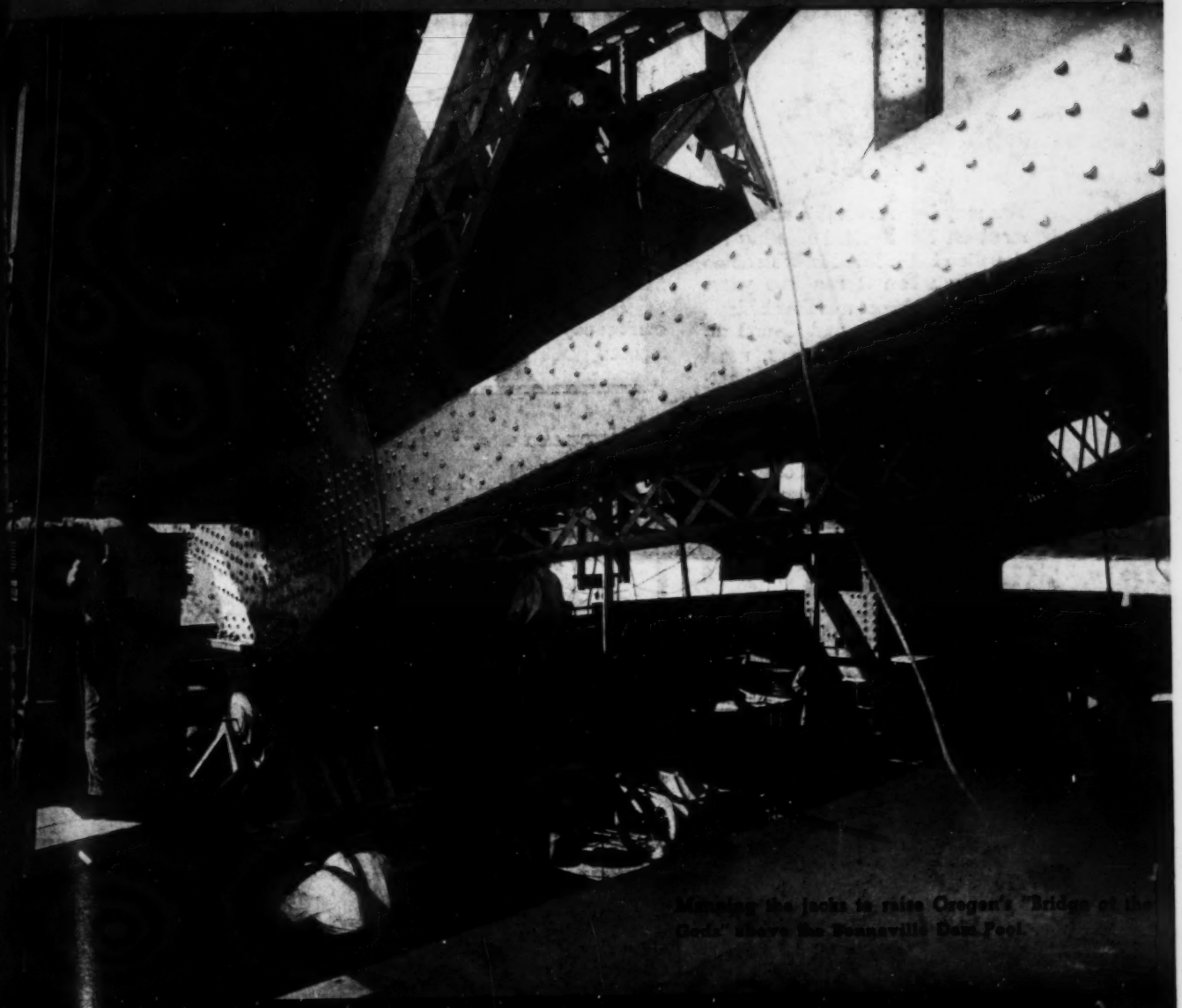


Manning the jacks to raise Oregon's "Bridge of the Gods" above the Bonneville Dam Pool

ding Baltimore's Big Tunnel — Unique Exploration at Kentucky Dam

REMEMBER this Ad on WROUGHT IRON in a RADIANT HEATING INSTALLATION?

It certainly started something!

You may have seen this advertisement on the Radiant Heating Installation in the Johnson Wax office building when it ran two years ago. The architect was Frank Lloyd Wright. Westerlin and Campbell, the Heating Contractors, used Byers Wrought Iron for the heating coils. After two full seasons of operation, the system is reported to have given thorough satisfaction, both from the standpoint of operating economy and comfort conditions.

The interest which this installation kindled has been amazing. Engineers have sent us over 2000 requests for literature and information. Several technical publications have run articles. And this interest is taking practical form in current projects.

. . . An industrial concern in South Carolina has just completed a Radiant Heating job in a new office building.

. . . A large New York State manufacturer is planning on two Radiant Heating installations.

. . . Another large manufacturer, in West Virginia, is contemplating the use of Radiant Heating in an emergency hospital now being designed.

. . . A mid-west concern with a large fleet of trucks is investigating the use of Radiant Heating in a new garage . . . because it promises to solve the difficult heating problem encountered in all such buildings.

For successful and satisfactory operation, the pipe material used in Radiant Heating must have good heat-transfer properties, and *must resist corrosion both from within and without.* Our interest in Radiant Heating comes from the fact that we *know* wrought iron's superiority in these respects. This knowledge is based on records of actual service, under identical conditions and extending over a long period of years. If you are contemplating the use of Radiant Heating, these records provide a sound, practical guide in selecting the most dependable material for coils, and eliminate any necessity for experiment.

If you are considering

RADIANT HEATING

We have been following the development of Radiant Heating since we furnished wrought iron pipe for an installation in 1928, and have accumulated a large amount of helpful data. This has been digested into a convenient bulletin, "Wrought Iron for Radiant Heating Installations." If you would like a complimentary copy, drop us a line.

A. M. Byers Co., Pittsburgh, Pa. Established 1864. Boston, New York, Philadelphia, Washington, Chicago, St. Louis, Houston, Seattle, San Francisco.

Corrosion costs you more than Wrought Iron

BYERS GENUINE WROUGHT IRON

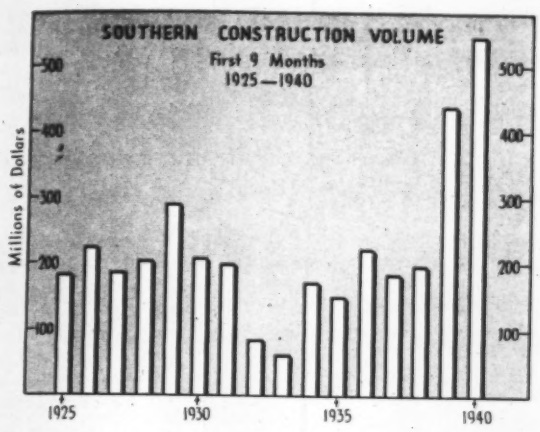
TUBULAR AND FLAT ROLLED PRODUCTS

STEEL TUBULAR PRODUCTS

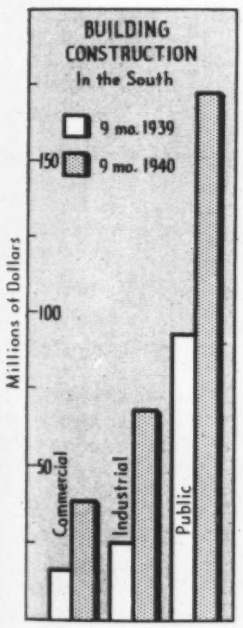
CONSTRUCTION TRENDS

Notes on significant movements in the construction industry

Records topple in South

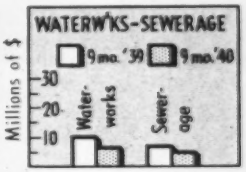


NATIONAL DEFENSE spending in the eleven Southern states has assured this region of a record construction volume for 1940. The total at the end of three-quarters of this year, $556,446,000, is 68 per cent ahead of the volume for the corresponding period last year, and already surpasses the all-time high of $454,250,000 established in the twelve months of 1939.

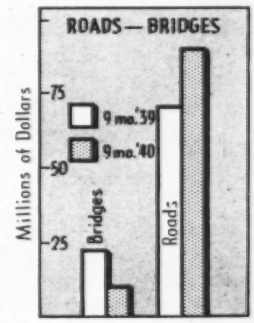


Six of the nine classes of work exceed their respective volumes of a year ago, and three of these, it will be noted, have more than doubled their 1939 nine-month totals.

Industrial buildings record the greatest gain, 178 per cent, as a result of privately-owned powder plant, utilities, and other allied defense construction. Military and naval airbases, airports and shipbuilding ways and docks have brought unclassified construction 155 per cent above a year ago, and an increase in privately-financed large-scale housing has boosted commercial building construction 134 per cent over the corresponding period in 1939.



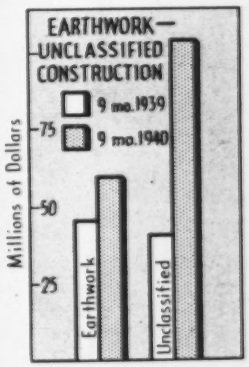
Cantonments, temporary barracks, defense workers' housing and government-owned powder plant construction combine to bring public building volume 86 per cent above the nine-month 1939 total. Earthwork and drainage, and streets and roads report gains of 30 and 29 per cent over their respective volumes of a year ago. Waterworks, sewerage and bridge construction, however, are 32, 35 and 56 per cent lower than last year, in that order.



Public building awards account for 31 per cent of the region's total; unclassified construction, 18.8 per cent; streets and roads, 16.3 per cent; industrial buildings, 12.3 per cent; earthwork and drainage, 10.8 per cent; commercial building and large-scale private housing, 6.9 per cent; bridges, 1.8 per cent; waterworks, 1.2 per cent; and sewerage, 0.9 per cent.

The South is responsible for 22.2 per cent of the nation's 1940 construction volume, 18.5 per cent of the private work, and 23.8 per cent of the public awards.

Federal construction for the nine months, $244,036,000, makes up 44 per cent of the total, and is five times greater than last year.



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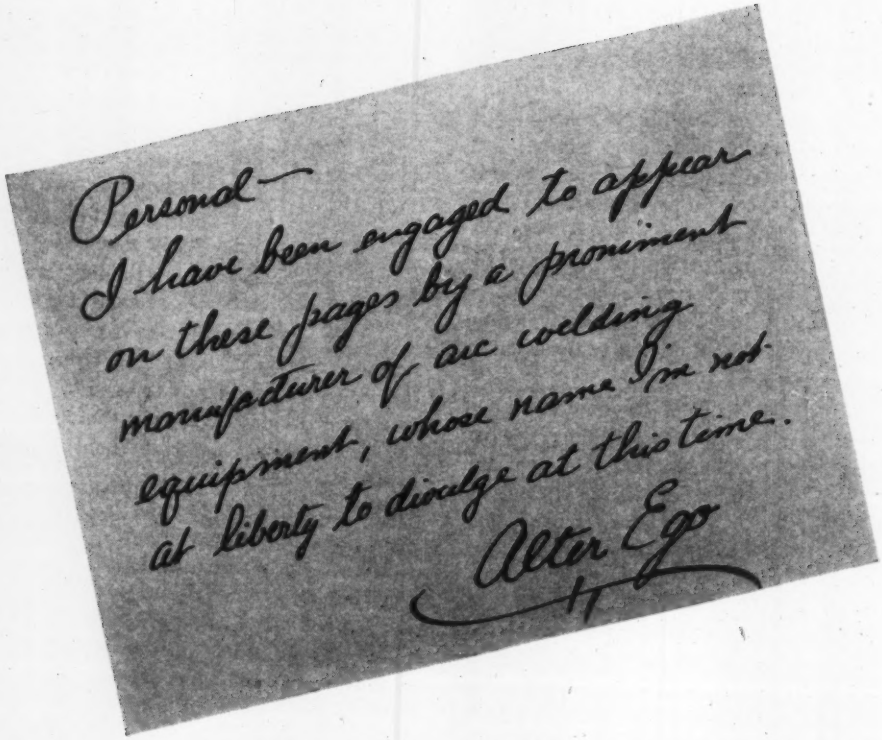

Personal—
I have been engaged to appear
on these pages by a prominent
manufacturer of arc welding
equipment, whose name I'm not
at liberty to divulge at this time.
Alter Ego

Public works men challenged by preparedness program

American Public Works Association Conference hears how municipal engineers may help in national defense preparations

Public works administrators will be challenged with many new problems arising from preparedness activities, Hubert R. Gallagher, assistant director, division of state and local cooperation of the Council of National Defense, pointed out at the annual meeting of the American Public Works Association in Detroit Sept. 30-Oct. 2. The conference, with a registration of 407 city engineers and other municipal officials, was the largest ever held.

Gallagher outlined the effect of the national defense program on cities, and told of a recently created division of state and local cooperation, which has been established by the National Defense Council to coordinate federal, state and local government activities. He cited housing developments and other public works expansion as calling for a careful supervision in industrial centers. "Here will be a chance to demonstrate," he said, "that a boom town economy does not result in a 'by guess and by gosh' type of frontier public administration."

A word of caution

Roy L. Phillips, newly elected president of the association, in a statement for *Engineering News-Record*, said, "Public works administrators must develop a national viewpoint concerning preparedness and they should actively aid in the suppression of selfish local interests." As an example he cited the fact that many communities, regardless of their location, are urging construction of airports for which they hope to obtain federal money. This is no time, said Phillips, for promotion of local activities at the expense of the nation as a whole. He also cautioned communities against the expansion of public works facilities in the mere hope of attracting industrial expansion during this emergency period.

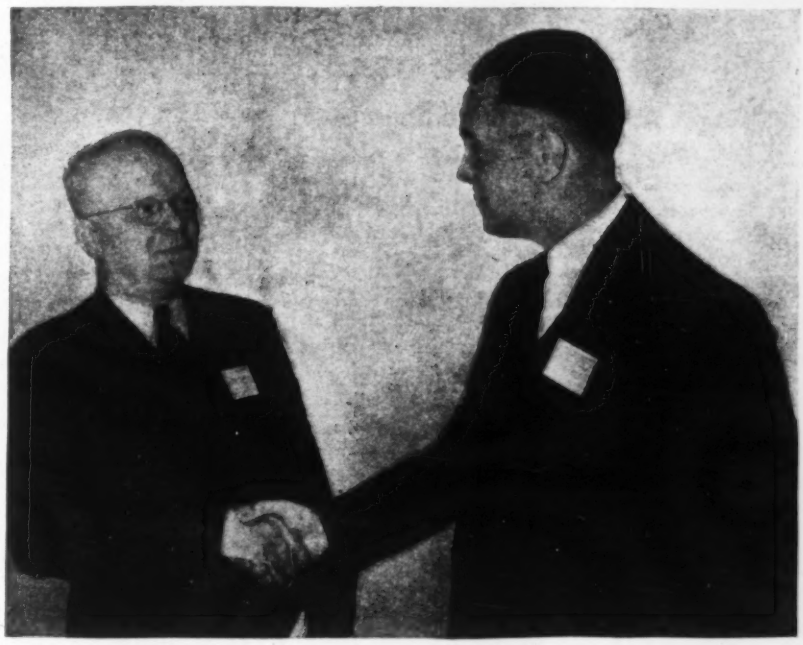
Supporting this view, Frank W. Herring, executive director of the association, said, "National welfare begins at home." Industrial operations, he pointed out, are in large part dependent upon the efficient functioning of public services such as water supply, sewerage, and transportation facilities. In fact, industrial production could seriously be hindered in the bottleneck of inefficient community service. Therefore, public works officials should view themselves in the role of indispensible agents for expediting defense preparation.

Aviation and roads

Speaking on aviation and its relation to roads, William Stout, airplane and motor car manufacturer and head of the Stout Engineering Laboratories of Detroit, said that mass production of small planes for private use is almost here. Even today, 60-hp. planes are available for as little as $1,300. In order to provide facilities to service these planes and give their owners maximum usefulness, landing strips will be necessary alongside highways. Michigan, he said, has already designated several locations for such strips and an appropriation has been made for their construction.

One of the highlights of the technical program was a report from James L. Ferebee, chief engineer of the Milwaukee, Wis. sewage commission, which exploded the theory that sale of sewage sludge for fertilizer produced big revenue returns to disposal plants. Figures compiled over a 13-year period showed that the total cost per ton of produced "Milorganite" a dried sludge chemical fertilizing agent) averaged $23.34; the net return per ton averaged $14.96.

Abstracts of the principal papers at the meeting are scheduled for publication in the November 7 issue of *ENR*.



Public works association gets new president

Roy L. Phillips, left, takes over the presidency of the American Public Works Association with the good wishes of the retiring president, John S. Flockhart.

Roy L. Phillips, city engineer of Meadville, Pa., was elected president of the association to succeed John S. Flockhart, principal assistant engineer, Newark, N. J. bureau of street cleaning.

Frederick T. Paul, city engineer, Minneapolis, was named first vice president, and Henry L. Howe, city engineer, Rochester, N. Y., named second vice president. Elected to the treasurer's post was Fred R. Storrer, city engineer of Dearborn, Mich.

New members of the board of directors are: Stuart M. Weaver, executive assistant to the commissioner of public works, Montclair, N. J., and Samuel Baxter, of the bureau of engineering, zoning and surveys, Philadelphia, Pa.

Defense housing bill passes with but one major change

Bill empowers Federal Administrator to build houses but omits restriction that he work through Public Buildings Administration

The $150,000,000 defense housing bill went through Congress with only one major change from its form as originally introduced (*ENR* Sept. 12, 1940, p. 317). In its final form the bill empowers the Federal Works Administrator to build houses and rent them to defense workers, military and civil; however, it omits the direction that the administrator work through the Public Buildings Administration, directing instead that he act through the Federal Works Agency, other public agencies, and local public agencies, i.e. local housing authorities.

The average cost of housing is limited to $3,500, exclusive of land, utilities, and community facilities except outside the continental United States where it may be $4,500. No unit is to exceed $3,950 in the States or $4,750 outside. Before and project can be built the President must certify that an acute shortage of housing impeding defense exists or impends and that private capital will not provide the needed housing.

Meanwhile, the Army turned over to Federal Works Administrator Carmody for execution a $45,762,500 program representing its share of $100,000,000 appropriated for defense housing some weeks ago independently of the bill passed last week. The Army program of 70 projects is intended to provide 1,950 dwelling units for civilian army employees and about 11,000 units for married enlisted men.

The Navy itself is doing the work in connection with its share of the $100,000,000 program. Individual projects have not yet been announced by the Navy.

Except for six projects, which are still confidential, the location and size of the army projects have been determined. These projects will be built by the Federal Works Agency.

R. A. Wurgel Photo

Thomas A. Edison bridge opened for weekend traffic

Providing for unobstructed flow of 5 lanes of traffic, the Thomas A. Edison Bridge over the Raritan River between Perth Amboy and South Amboy, N. J. has been opened to weekend traffic, pending final completion of the approaches. The bridge is located on State Route 35 and U. S. 9 about 4 miles south of the Woodbridge cloverleaf on U. S. 1 and will carry unusually heavy traffic to the New Jersey shore resorts.

The substructure is a series of deep foundations sunk partly by the pneumatic caisson methods, ENR July 4, 1940, p. 30. The superstructure over the river consists of one 250-ft. and eight 200-ft. plate girder spans flanked by six 152.5-ft. and six 84.5-ft. spans on the north approach and eight 132.5-ft. spans on the south to make the total length 4,386 ft. Feature of the design and construction were the girders used for the 250-ft. span. The big girders are 20.5 ft. deep; their weight of 198 ton is believed to make them the largest girders ever erected in one piece. Some difficulty was experienced during erection due to the natural limberness of the long members, despite a special system of temporary hog ties.

The roadway is 52 ft. wide with emergency footwalks on each side. Originally intended for two 24 ft. roadways separated by a center mall the roadway has been rearranged to have 5 lanes of traffic controlled by overhead lights. It is expected that two lanes will always be operated in each direction, the fifth lane being alternated to accommodate traffic in the direction of prevailing flow.

The New Jersey State Highway Department, James Logan, state highway engineer, and Morris Goodkind, bridge engineer, designed the crossing with the assistance of Ash-Howard-Needles & Tammen, consultants of New York and Kansas City. The superstructure was erected by the Bethlehem Steel Co.; the piers were built by Peter F. Connolly, Co., New York, N. Y.; the south approach by the Fehlhaber Pile Co., New York; and the north approach by J. F. Chapman & Sons, Hillside, N. Y.

A PWA grant of $2,113,000 aided in financing the structure, which will cost about $4,670,000.

WASHINGTON HIGHLIGHTS

A STEP TOWARDS the creation of a Columbia Valley TVA was taken with the introduction last week with administration support of a bill which would create a Columbia Power Administration to market the power from Bonneville and Grand Coulee. The proposed administration, which would not operate the dams, would be empowered to sell $200,000,000 in bonds, to build transmission lines, and to buy existing lines and connected generating plant for resale to municipalities or utility districts. The latter feature, crux of the bill, would solve the present inpasse in the effort of valley Public Utility Districts to buy out the local utility companies.

Airfield fund cut in half as civil supplementary bill passes

Appropriation includes $7,500,000 for Bonneville work; $9,000,000 for engineering short courses; and $18,663,000 for District of Columbia buildings

The proposed $80,000,000 appropriation for construction of civil airfields was cut in Congress to $40,000,000 and the appropriation passed in that form. The money may be used on not more than 250 public airports and landing areas; they must be approved as necessary for the national defense by a joint Army-Navy-Commerce board. Thus the Civil Aeronautics Administration can start its big airfield program (*ENR* Sept. 26, 1940, p. 386) but is precluded from using initial money to make a small start on every field in the program.

This money was included in the civil supplementary appropriation, one of two appropriations which cleared Congress last week. The bill also appropriated $7,500,000 for further work at Bonneville—$3,500,000 for distribution lines, and $4,000,000 to permit immediate installation of generators 7, 8, 9, and 10. This, it is asserted is required because of the expansion of load arising from the defense program. A major item in the increased load is a defense plant proposed by "X" company.

Other items of engineering interest in the two appropriation bills include: $9,000,000 for a program of engineering school short courses (*ENR* Sept. 12, 1940, p. 318); $18,662,000 for building in the District of Columbia; $2,700,000 for hangars and utilities at the Washington National Airport; $2,500,000 to complete Marshall Ford Dam and $400,000 for the Pine River project; $8,127,000 for rivers and harbors—principally the Philadelphia Navy Yard 40-ft. channel and a Los Angeles harbor breakwater—and $1,100,000 for the U. S. share of bridge alteration costs under the new allocation policy (*ENR* Sept. 12, 1940, p. 323); and $9,500,000 to start a $10,000,000 drydock in New York harbor and a $5,000,000 naval depot at the Bayonne, N. J. terminal plus a $3,000,000 auxiliary airfield at the Corpus Christi, Tex., naval air training center.

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Texas flood-control work to start soon

At the direction of the attorney general of Texas in a rehearing of the Harris County, Texas tax remission case, which was overruled by the state supreme court, the last barrier to a $31,590,000 flood-control system for Harris County, of which Houston is the county seat, has been removed, and work on the project is expected to start soon, according to an official announcement. Out of the total cost of $28,800,000 about $21,190,000 will be spent for construction, $6,115,000 for right-of-way, $1,283,000 for relocation of highways and bridges and $200,000 for clearing the necessary land. The total figure also includes $2,799,000 from the WPA supplemental flood-control fund.

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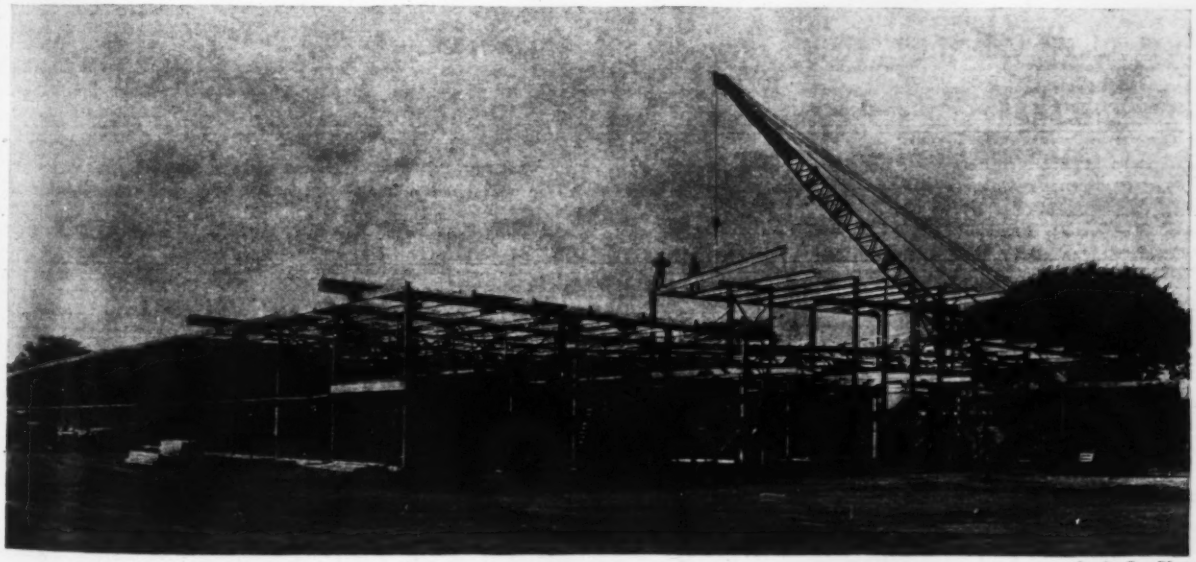
Concreting accident kills spectator at Los Angeles

Failure of the falsework caused the collapse of a 100 ft. reinforced concrete beam, while being poured, in Los Angeles Sept. 23. One person, a spectator, was killed and several workmen were injured. The beam, 16 ft. deep and 18 in. wide, was to have formed the support for the roof and superstructure over a large vegetable market. Total weight of the beam would have been 120 tons.

Pouring for the member began at 6 a.m. with transit mix concrete, and failure occurred at 3 p.m., when about two-thirds of the necessary concrete was in place. Design of the beam and materials used were checked by the Los Angeles County Building Dept. before and after the accident and were found to be satisfactory. Jackson Bros. & LeSage of Los Angeles, are contractors on the building.



Austin Co. Photo

All structural steel in place 30 days after awarding contract

Just one month after awarding the contract to the Austin Co. for design and construction of a $250,000 windowless, controlled-conditions plant, all structural steel was in place for the plant. The first section of the building, which will be used by the Collins Radio Co., Cedar Rapids, Ia., to produce aircraft radio equipment, is expected to be ready for production early in November.

The new plant will be completely air conditioned and lighted entirely by fluorescent tubes. The structure's only windows will be a narrow band of fixed double glazed sash for the offices extending across one end and a plate glass window over the main entrance.

Edward J. Harding dies; A.G.C. managing director

Edward J. Harding, managing director of the Associated General Contractors of America, died Oct. 5 while visiting in Plainfield, N. J., where he planned

Brooks Photo

Edward J. Harding

a short stop before beginning a vacation cruise to the West Indies.

Harding had been with the A.G.C. for 21 years. After its formation in 1919 he became field secretary, in 1926 membership manager, in 1929 assistant general manager, and managing director in 1930.

His first contact with the construction industry was in 1906 in connection with the condemnation of land for the Hudson Tunnel in New York. From 1917 to 1921 he was manager for James Stewart Co., general contractors of New York City, on many World War construction jobs. These included: Camp Pike, Little Rock, Ark.; Camp Bragg, Fayetteville, N. C.; Coast Air Station, Long Island, N. Y.; Camp Barges, Baldwinsville, N. Y.; naval base and arsenal at Norfolk, Va.; and two projects at St. Nazaire, Vincennes, France.

In addition to his recent regular duties, Harding was serving as a member on the Construction Advisory Committee to the Army and Navy Munitions Board. He was also a member of the Federal Advisory Council for Employment Security.

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James J. Clifford, well-known builder, dies

James J. Clifford, 63, supervisor of erection for the general contracting firm of Vermilya-Brown Co., Inc., New York, died in Westville, Conn. Oct. 3. Clifford directed the construction of ten new Yale colleges and the Sterling Memorial Library and the Payne Whitney gymnasium at Yale while with Marc Eidlitz & Son, Inc.

JOBS OF THE WEEK

TANK PLANT, Detroit, Mich.

O. W. Burke Company, Detroit, Mich., was awarded the contract for constructing a 1,380-ft. army tank arsenal by the Chrysler Corp., Detroit, Mich. The work is expected to cost $20,000,000. Albert Kahn, Detroit, is architect. The War Department negotiated a contract in August with Chrysler for construction and operation of the plant.

TOLUOL and EXPLOSIVE MANUFACTURING PLANT, Baytown, Texas.

War Department awarded a contract to the Humble Oil & Refining Co., Houston, Tex., for the construction and operation of a toluol and explosive manufacturing plant near Baytown, Tex. The work will be done by the oil company's own forces with the company purchasing materials. Estimated cost of the work is $9,500,000.

ARMORED PLATE PLANT, Philadelphia, Pa.

Barclay White & Co., Phila., Pa., received from the War Department the contract for constructing a plant addition for manufacturing armored plates. Henry Disston & Sons, Inc., Philadelphia, Pa. will operate the plant for which Irving S. Towsley, Philadelphia, is engineer and architect. The plant and equipment is estimated to cost $1,018,400.

AMMUNITION STORAGE FACILITIES, Hawthorne, Nev.

William T. Neil Co., Los Angeles, Calif. will construct additional ammunition storage facilities at Naval Ammunition Depot for the Navy under terms of a $2,146,000 contract.

CANTONMENT, Indiantown Gap, Pa.

W. F. Trimble & Sons Co., Pittsburgh, Ferguson and Edmondson Co., Pittsburgh, and Huffman-Wolfe Co., Columbus, O., were awarded a $5,413,735 contract on a cost-plus basis for a National Guard Cantonment. Gannett, Eastman & Flemming, Harrisburg, Pa., will act as engineers and architects. The War Department negotiated the contract for the work.

CANTONMENT, Fort George G. Meade, Md.

Consolidated Engineering Co., Inc., Baltimore, Md. will build on a cost-plus basis a construction camp for the War Department. J. E. Greiner Co., Baltimore, Md. are architects and engineers for the project, which is estimated to cost $7,354,000.

CANTONMENT, Camp Hulen, Palacios, Tex.

Knutson Construction Co., Russ Mitchell, Inc. and T. B. Hubbard Construction Co., Houston, were awarded a joint contract for 128 frame buildings; 832 tent frames; a hospital; utilities, and all other construction for Camp Hulen. Constructing Quartermaster, War Department, awarded the contract with the work expected to cost $2,000,000.

CANTONMENT, Fort Lewis, Wash.

Sound Construction Co., Seattle, and Peter Kiewitt & Sons Co., Omaha, Neb. were awarded a $4,711,000 contract for temporary buildings for the National Guard Cantonment. MacDonald & Kahn, San Francisco, got a $1,550,000 contract for the hospitals and utilities.

FACILITIES AT NAVAL TRAINING STATION, Great Lakes, Ill.

Henry Ericsson Co., Chicago, Ill., was awarded a contract on a cost-plus fee basis for temporary buildings and facilities for enlisted personnel at Naval Training Station. The work, being done by the Bureau of Yards & Docks, Navy Department, Washington, D. C., is estimated to cost $1,200,000.

NAVY YARD HOUSING, Mare Island, Calif.

Barrett & Hilp, San Francisco, Calif., will construct under provisions of a $2,256,118 contract 600 low cost dwelling units for workers at the Mare Island Navy Yard. The Bureau of Yards & Docks, Navy Department, Washington, D. C., is doing the work.

AIRPLANE FACTORY, Bethpage, N. Y.

The Austin Co., New York, N. Y. got the contract for constructing a blackout factory for the Grumman Aircraft Engineering Corp. The plant, estimated to cost $2,500,000, will be windowless, air conditioned and lighted by fluorescent tubes. The plant will be for manufacturing naval aircraft.

YARD IMPROVEMENTS, Roanoke, Va.

Norfolk & Western R. R., W. P. Wiltsee, chief engineer, is improving and making additions to its Norfolk Yard with its own forces at a cost of $4,700,000.

AIRCRAFT PLANT, Wichita, Kansas.

The Austin Company, Cleveland, O., was awarded a contract for constructing two airplane factories, one 100x100 ft. and other 200x1,000 ft. for the Boeing Aircraft Co., Seattle, Wash. The work is estimated to cost $1,500,000.

NOTE—Additional bidding and contract news on over 600 projects, large and small, appear in the Construction News Section beginning on page 127.

National Sewage Works Association gets vote of unanimous approval

First convention of state and local associations draws 550 members to Chicago where 56 manufacturers exhibited equipment. New chemicals for treatment are announced

Unanimous endorsement of the move to form a strong national organization of workers in the field of sewage disposal was given at the first convention of the twelve-year-old Federation of Sewage Works Associations held in Chicago Oct. 3-5. More than 550 members of local associations were at the meeting which was held in conjunction with the annual meeting of the Central States Sewage Works Association.

Opposition to the move, which originated last January in some of the 22 existing local organizations when reorganization along national lines was proposed, had melted away, and it now remains only for the board of control of the federation to vote on the new constitution. It is generally conceded that favorable action will be taken when the board meets in January.

The reorganization is designed to give national unity and voice to sewage works operators and designers, provide for standardization of practice, and assure cooperation with equipment manufacturers in furthering objectives of mutual interest, according to Charles A. Emerson, chairman of the federation.

Manufacturers appoint committee

Equipment manufacturers, 56 of whom had exhibits at the convention, will coordinate their activities through the medium of the recently organized Water and Sewage Works Manufacturers Association. At a meeting of this group held during the convention, a sewage works executive committee was appointed consisting of representatives from The Dorr Co., Pacific Flush Tank Co., Link-Belt Co., Nichols Engineering and Research Corp., Case-Sheppard-Mann Publishing Co., R. D. Wood Co., Pittsburgh-Des Moines Steel Co., and Wallace and Tiernan. D. S. McAfee, vice-president of The Dorr Co., was elected chairman of this group.

Stream standards scrutinized

Abel Wolman, professor of sanitary engineering, Johns Hopkins University, called upon the revitalized federation to undertake, as one of its first responsibilities, a study of sewage treatment plant installations in relation to stream cleanliness. Among other things he questioned the high degree of treatment which is required by some authorities in certain streams, saying that present standards of pollution control fall far short of intelligent application.

Expenditures for sewage disposal in the next two decades, said Wolman, will probably exceed a billion dollars. "No more important problem confronts the profession than how to steer a reasonable course between perfectionists and the opportunists in this difficult field", he concluded.

New chemicals for treatment

Of special significance in the technical sessions, a complete report of which is scheduled for the Nov. 7 issue of *ENR*, was the first public announcement that two new chemicals had been developed for sewage treatment, the application of which is more effective and cheaper in cost than the chemicals now employed. The compounds, which are complex combinations of certain elements developed in the laboratories of the New Jersey Agricultural Experiment Station, were described by Willem Rudolfs, chief of the division of water and sewage.

Officers elected

Officers elected by the Central States Sewage Works Association with which the federation held its convention were: C. C. Larson, president; George Martin, H. L. Mick and Don Bloodgood, vice-president; W. H. Wisely, secretary-treasurer.

An award for the outstanding paper of the year was given to William A. Dundas, The Sanitary District of Chicago, for his description of the flash-drying system of sludge disposal.

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Defense workers list now includes construction

Certain construction trades have been included in the list of nearly 500 skills important to the defense program in which the federal employment service keeps detailed statistics of men available. These skills were chosen principally with an eye to the fact that men having them were likely to be drawn away into other industries, leaving a shortage in construction.

The first survey of these skills shows that late in August, 4,560 structural steel workers were available for work, as were 12,048 form builders, 343 construction draftsmen, 1,295 architectural draftsmen, 260 structural draftsmen. Other construction occupations listed were: Asbestos worker, 824 men; heating and ventilating draftsmen, 50, plumbing draftsmen, 11; refrigerating engineers, 686.

In addition, 600 men listed steel work and 2,600 men form work as second choice occupations.

These figures, of course, do not represent all the men in these classifications who are available for work, but only those registered with the public employment offices. All the men registered as having these skills have been re-examined, their job records checked, and in some cases their skills tested; the employment service is confident that when it lists a man as a structural steel worker he is actually capable of holding down a job at that trade.

The geographical distribution of the men listed is very uneven, more than a third being concentrated in New York, Texas, and California.

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Lower hour pay studied to increase total wages

Eastern local union suggests experiment, which would call for closed union shop with contractor

A limited step towards an annual wage experiment in the construction industry was made known last week when the anti-trust division of the Department of Justice revealed that it had been asked to pass upon a proposal, by an unspecified union group, involving the acceptance of a weekly wage, at a reduced hourly rate, in an effort to increase the volume of construction and the total wage of the workers.

The plan suggested provided for an agreement between a local union somewhere in the East and a group of painting contractors that a weekly wage of $32 replace hourly rates now averaging $45 per week in the hope of increasing volume of work. In return, the contractors agree to hire only members of the union and the union would close its roles for a year to new members. It was this last point in the plan that prompted the inquiry to the Department of Justice whether the plan might violate the anti-trust laws.

The department took the position, in replying to the query, that since the objective was to increase rather than to restrain trade, the "incidental restraint" on commerce involved in closing the union roles is permissible.

It is not known whether the inquiry was largely academic or whether it will be put into effect soon. Contractor circles commenting on the plan expressed the hope coupled with some trepidation, that the experiment might offer a test of the theory—often unsuccessful expounded to union negotiators—that lower hourly wages would mean more work and a greater total income for the workers.

OBITUARY

ROLAND W. BROOKS, 64, retired superintendent of construction for the American Bridge Co., died in Atlanta, Ga., Oct. 3.

WESLEY L. HARDY, 46, general building contractor of Redwood Falls, Minn., died at Rochester, Minn. recently.

RENNIE B. FANNING, 72, for the past 50 years engaged in hydraulic and civil engineering, died early this month in Minneapolis.

WILLIAM PERCY WILGAR, professor of civil engineering and head of the civil engineering department at Queen's University, Kingston, Ont., died recently in Ottawa.

FRED C. DREHER, president of the F. C. Dreher Contracting Co. of Denver, died in that city last month.

JOSEPH RIPLEY, 87, former consulting engineer for the New York state department of public works, died Sept. 28 in Albany. Following graduation from the University of Michigan, he was employed on the St. Mary's Falls canal and for several years as senior consulting engineer for the New York barge canal.

WILLIAM H. MORGAN, 67, county surveyor of Madison County, Ill. and city engineer of Edwardsville, Ill., died Sept. 26 in Alton, Ill.

JAMES B. WILCOX, 79, former construction engineer for the C.H.&S. R.R., died recently in Columbus, Ohio.

FRANK J. WALLENTA, 63, partner in the firm of Meers & Wallenta, general contractors of Memphis, Tenn., which he organized in 1928, died Sept. 27 at Memphis.

CHARLES VICTOR SEASTONE, 68, hydraulic engineer and partner of Daniel W. Mead in the firm of Mead & Seastone for 24 years, died Sept. 26 in Madison, Wis. Seastone went to Madison in 1907 after teaching at the Illinois and Purdue universities. Since 1933 he had been a consulting engineer for Mead, Ward & Hunt, consultants of Madison. He was chairman of the Madison Metropolitan Sewerage Commission.

GUSTAVE STEINHAGEN, SR., 86, civil engineer of Milwaukee employed in the construction of the Brooklyn Bridge and consultant for many of Milwaukee's bridges and viaducts, died in that city Oct. 2.

CONTRACTS AND CAPITAL

ENGINEERING CONSTRUCTION awards for the week total $84,797,000, an increase of 20 per cent over the corresponding week last year, but 10 per cent under the volume of a week ago.

Defense awards continue to spur public construction, boosting the current week's public total 97 per cent above a year ago, and 2 per cent above last week. Private construction, however, is 44 per cent below last year, and 33 per cent under last week.

The week's volume brings 1940 construction to $2,681,951,000, an increase of 12 per cent over the total reported for the 41-week period in 1939. Private awards top last year's mark by 19 per cent, and public construction is 9 per cent ahead of a year ago as a result of the 179 per cent gain in federal work.

New capital for construction purposes for the week totals $156,997,000, an increase of 308 per cent over the volume reported for the corresponding 1939 week. The week's financing is made up of $150,000,000 in federal appropriations for defense workers' housing, $6,145,000 in state and municipal bonds, $775,000 in corporate security issues, and $77,000 in RFC loans for public improvements.

The new construction financing total for the 41 weeks of 1941, $3,352,036,000, tops the total reported for the period last year by 51 per cent.

CONTRACTS

(Thousands of dollars)

	Week Ending Oct. 12 1939	Oct. 5 1940	Oct. 10 1940
Federal	$9,151	$37,436	$39,042
State & Municipal	22,951	24,824	24,276
Total public...	$32,102	$62,260	$63,317
Total private..	38,541	31,921	21,480
TOTALS	$70,643	$94,181	$84,797
Cumulative			
1940 .....(41 weeks)....			$2,681,951
1939 .....(41 weeks)....			$2,388,823

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial building, $40,000; other buildings, $150,000.

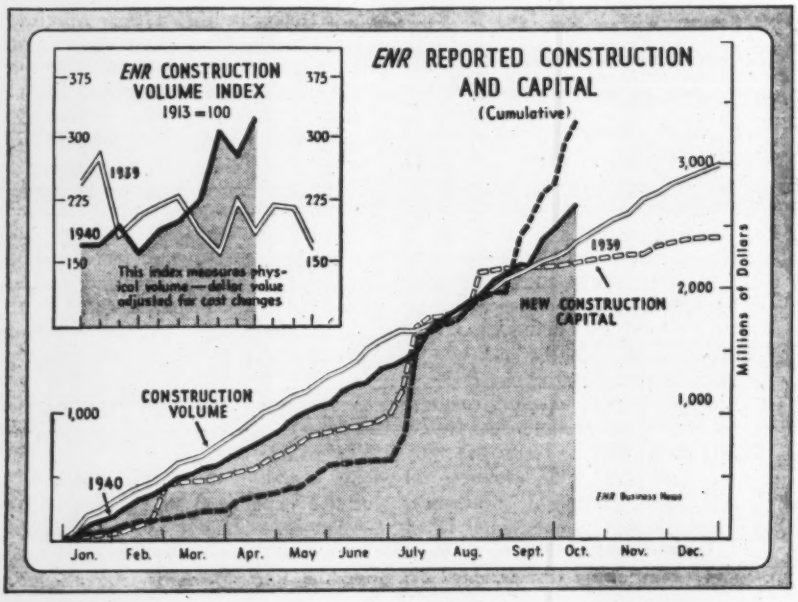
NEW PRODUCTIVE CAPITAL

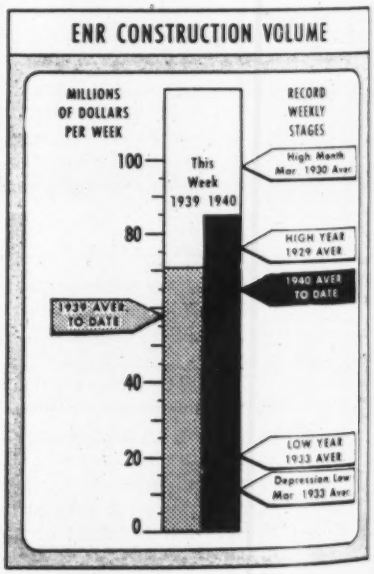
	1939 41 Wks.	Cumulative 1940 41 Wks.
NON-FEDERAL ..	$1,095,448	$1,199,288
Corp. Securities.	185,260	207,394
State & Mun....	424,781	391,758
R.E.A. loans....	89,445	40,000
U.S.H.A. loans..	201,647	180,465
R.F.C. loans....	4,315	195,671
Fed. Aid-Hwy...	190,900	184,000
FEDERAL	$1,128,028	$2,152,747
TOTAL CAPITAL.	$2,223,476	$3,352,036

FHA MORTGAGES

	Week Ending Oct. 7 1939	Sept. 28 1940	Oct. 5 1940
Selected for appraisal	$22,956	$28,797	$26,568*
Cumulative			
1940 .....(40 weeks)....			$1,012,289*
1939 .....(40 weeks)....			$899,237

* Subject to revision.





Lumber price rises result in indictments

Restriction and allocation of output, price fixing, and grade marking abuse charged

Inferrentially charging that recent increases in lumber prices are a result of collusion among lumber producers, the Department of Justice last week obtained indictments on anti-trust charges against five lumbermen's associations, 168 lumber companies, and 53 company officials. In announcing the indictments, the department pointed to the rising price of lumber, asserted on the basis of defense commission statements that there is no economic justification for the increases, and charged that higher than commercial prices have been quoted on lumber for army camps. "Restoration of competitive prices upon West Coast softwoods," the department said, "is expected to check increases upon competing species and also to serve as a warning that where rising prices are due to collusion they will be dealt with promptly."

The charges in the indictments include restriction and allocation of output, fixing of prices, and abuse of grademarking —charges similar to those on which the department last Spring obtained a consent decree from the Southern Pine Association.

Alleged abuses explained

Alleged abuses of grade marking included efforts to induce buyers to accept only western pine bearing the associations' grademark, charging non-members substantially higher grading fees than those charged members, efforts to prevent recognition of other grademarks, and discrimination in the granting of authority to certain retail yards to apply the grademark.

Associations under indictment are: West Coast Lumbermens Association, National Lumber Manufacturers Association, Intercoastal Lumber Distributors Association, Lumber and Allied Products Institute of Los Angeles, Western Pine Association. Companies indicted include such prominent firms as Weyerhaeuser, Long-Bell, Algoma, Boise-Payette, Brooks-Scanlon, Coos Bay, Red River, and Shevlin-Hixon.

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Sale of hurricane lumber arranged by government

The U. S. Forest Service announced Sept. 26 that it had closed a contract for the sale of 425,000,000 board feet of the lumber salvaged after the New England tropical hurricane of September 1938 to the Eastern Pine Sales Corp., Chicago, which was formed to sell the lumber.

President of the corporation is Harry Joseph of Chicago and the vice-president and sales manager is David M. Osborne of Boston, who will direct the finishing of the lumber which is rough-sawn.

The contract with Eastern Pine Sales provides that 33,000,000 ft. are to be taken the first year, and 120,000,000 ft. each year thereafter with the contract to run for 4¼ years. Price will be adjusted to the actual market every 90 days to assure the government a fair return. Present market value of the lumber is estimated at eight to ten million dollars, considerably less than the amount advanced to the Salvage Administration by the Reconstruction Finance Corporation for payments to owners and for expenses.

In announcing the sale contract, the Forest Service explains that the lumber could not be used for army cantonments or other defense building because of its unfinished condition, gaps in grades and sizes, and inability of the product to meet the rigid standards of the defense agencies.

Still remaining in government ownership are some 200,000,000 ft. of logs in water storage. This material is not involved in the present Eastern Pine Sales deal.

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Tolls from Washington spans exceed estimate

Tolls from the Lake Washington Pontoon Bridge at Seattle during the first two months of operation were $107,770, while at Tacoma Narrows bridge, opened a day earlier, tolls were $126,932, according to the Washington Toll Bridge Authority. Both totals are above the estimated revenues used by the authority in figuring on bond retirement.

The Seattle bridge was used by 321,246 vehicles, including 302,189 automobiles, 12,073 trucks and commercial vehicles and 4,048 buses. The Tacoma span was used by 141,474 vehicles, including 137,287 automobiles, 10,690 trucks and commercial vehicles and 1,585 buses.

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Equipment bombed on Illinois bridge job

On Sept. 29 machinery used in the construction of a bridge over the Big Muddy River in Jackson County just south of Murphysboro, Ill., was damaged by bombs to the extent of $5,000. No comment is available from county law enforcement agencies, but County Highway Engineer Albert Stallions reports that union labor representatives from a nearby county appeared before the county road and bridge commissioner a short time ago objecting to the use of WPA labor for the work.

Right granted to store Brazos River water

The Texas State Supreme Court has granted the Brazos River Conservation Reclamation District the right to close the gates of the Possum Kingdom Dam in Palo Pinto County, Tex., for storage of Brazos River water, providing a cash security is posted to cover damage to land inundated. The decision called for the dissolution of a district court injunction which had restrained the district from impounding water by the large flood-control project; a group of property owners had challenged the district's authority to close the gates before adjudication of the disputes arising over values fixed for the property to be flooded.

Previously the supreme court had upheld the validity of the district's creation.

Additional details on the Possum Kingdom project, the major unit in the extensive flood control project for the Brazos River Valley, are given in *ENR* June 8, 1939, p. 757.

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Many bid on demolition of New York World's Fair

Fourteen firms submitted bids on the demolition of 59 buildings owned and operated by the New York World's Fair Corp. when bids were opened on Oct. 8. The low bid was $148,000 for the entire eight zones into which the fair grounds had been divided for the purpose of bidding. It was submitted by John J. Abramsen Co., Bronx. The high bid was $550,000. An added item of $5,780 was included in the Abramsen bid for demolition of two buildings in the amusement area, the Independent subway station and two utility buildings.

A combination of the low bids on the eight zones, of which Abramsen submitted five, was $128,708. The Fair corporation has 30 days in which to act, and the work must be completed in four months.

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Britain to control civilian construction

As part of the war effort, Great Britain placed in effect Oct. 7 a regulation requiring a government license for all new civilian construction projects not essential to the war program. Buildings costing less than about $2,000 in American money will be banned. Also work may be stopped on many projects where it is felt the outlay for materials and labor is not justified.

Reconstruction of damaged property will be permitted only in cases where the property in question is of value to the British cause.

The only building material reported difficult to obtain is cement.

Comment and Discussion

Readers' opinions on matters that concern engineers and contractors

Dredging at Hudson Bay

Sir: In your issue of Sept. 12 under a picture captioned "Job Assembled Equipment Improves Canadian Navigation", there is the statement, "First dredging done in the arctic waters of Canada has been completed on the Athabasca River near Fort MacMurray, Alberta."

Unless the above refers to the inland waters of Canada, the statement is incorrect, for dredging has been performed for a number of years at the Hudson Bay harbour of Churchill, Manitoba, which is approximately 125 miles farther north than Fort MacMurray.

G. S. ANDERSON
National Harbours Board
Ottawa, Canada

Credit for the Job

Sir: Your issue of Sept. 12 has on page 61 an illustration of the bronze tablet commemorating the completion of the Hansen Dam and Flood Control Basin. It is notable for the extensive credit given to the army officers connected with its construction and for the lack of any credit to their civilian assistants that presumably were engaged also on the job.

A good many years ago, I was a junior engineer with the U. S. Engineers and know from first-hand experience the extent of the dependence of army officers upon the technical and executive ability of their civilian assistants. I doubt if conditions in that respect are any different today.

The outstanding characteristic of a broad-gauge, engineering executive is the freedom with which he gives credit to assistants for work well done. His technical education alone is sufficient to leave him with the consciousness of how little he knows compared with the wealth of knowledge available. I do not believe that the U. S. Engineer officers connected with the Hansen Dam would have lessened their reputation for ability in any way by including the names of one or two of their chief civilian assistants on the tablet.

Much is heard of the complaint of engineers that they do not get the recognition from the general public that the character of their work justifies. How can they expect it if they are not more than fair to their associates in giving credit where credit is due? In this respect U. S. Engineer officers as members of the engineering profession have as great an obligation to their engineering associates as any other member of the profession.

GREGORY M. DEXTER
Scarsdale, N. Y.

Watch Well Supplies

Sir: The article *Sabotage and Water Service* (*ENR*, July 18, 1940, p. 50) and the discussion that it inspired related largely to the protection of surface supplies. Little, if anything, has been said about the danger of sabotage to underground sources. There are many cities dependent wholly upon groundwater and in which there are essential defense industries. Furthermore, in many cities where the public supply is derived from surface sources, numerous industries use groundwater. A few instances, described in such a manner as not to reveal specific localities, will serve to show some of the possibilities of sabotage of groundwater supplies.

Where groundwater is used a number of wells are generally employed. A few men can guard a dam, but at least one man will be needed to guard each isolated well. In one city all water for both the public supply and industries is obtained from wells in perhaps 150 separate localities. There are at least three industries in this city of primary importance in the manufacture of defense materials, and the city is a rail center through which there may be large movement of troops, equipment and supplies. At one plant manufacturing an essential ingredient of ammunition a well pump stands close to the street not protected by fence or house. Many wells for the public system are in brick houses, but some are not so housed, and they could be quickly put out of commission by merely removing a pipe cap and dropping in charges of explosives. In one place the location of a feeder line from several wells to a central pumping station is revealed by an air vent pipe. An explosive charge dropped in it might cut off perhaps a fourth or fifth of the supply.

In a city near one of the nation's most important air training centers, both the city and the airfield, as well as industries, are wholly dependent upon groundwater. The wells of the airfield are within the guarded and fenced area of the military reservation. In contrast, when the writer and several companions visited the city waterworks several months ago, we wandered through the building, examined the pumps, motors and other equipment for fifteen minutes without seeing any operator.

At a plant of an important defense industry there is in progress large expansion that involves the development of a new well supply. The plant is surrounded by fence floodlighted every 200 ft., and posted with armed guards. In contrast, at a factory where equipment for the water-supply system of the first-mentioned plant was being made along with equipment for the Army and Navy, the gate was open and unguarded, and we wandered around without challenge. The plant superintendent passed off a question as to the danger of sabotage with the reply that if a piece of equipment in process of manufacture should be damaged a new one could be turned out in 24 hours. But the writer was not convinced that damage to the primary equipment of the plant—to plans and specifications and to lathes and other machines—might not result in serious delays. Contracts for developments of water supply might well include clauses to require as much protection from sabotage during the manufacture and installation of equipment as the owner of the system would provide after it is completed.

The problem of sabotage of groundwater supplies is one to be seriously considered. Certain minimum precautions should be taken. These include the housing of wells and pumps in substantial structures, and the floodlighting and perhaps fencing of them. The suggestion of cross-connections between industrial wells and public supply systems may be anathema to waterworks officials and health department authorities. Nevertheless there are many places where provision should be made for cross-

connections, at least to the extent of having the pipe and materials on hand and ready to be connected in an emergency. Now that the Army is to be increased it would seem proper to have it station guards at many of the most critical points.

A final suggestion may be made that is not directly related to sabotage. It has been the experience of the Division of Ground Water of the Geological Survey that many well owners pay little attention to their wells and pumping equipment after installation so long as water comes out of the ground. They have no idea as to whether the yield of wells and pumps is "holding up," or whether there is any significant change in the groundwater level or artesian head. Also in many places authorities of the public water system have practically no information as to what supplies may be available from privately-owned wells. Some increase in consumption of groundwater is to be expected in many places as a result of increased activity; and in turn this may be expected to cause the water level to decline to levels lower than during the past several years. Such decline in water level or artesian head is not necessarily an indication of overdevelopment, but is to be expected as a condition necessary to provide the needed flow of water to the wells. On the other hand, in some localities there may be actual danger of overdraft. In either case, if the water level is already near the end of suction pipes, or perhaps even near the bottom of the wells, trouble may unexpectedly occur. It will be only a wise precaution for well owners to look into the adequacy of the supply of groundwater.

DAVID G. THOMPSON
Senior Geologist, Geological Survey
U. S. Dept. of the Interior, Washington

Engineering Council

Sir: American Association of Engineers is perhaps remiss in that it did not comment earlier on your editorial of Aug. 15, in regard to American Engineering Council. Because our relations with American Engineering Council have been most cordial, we, rather than the president of American Engineering Council, should have refuted the implication in your statement that "another weakening factor was the Council's lack of interest in the professional groups such as the American Association of Engineers."

Because A.A.E.'s field of activity is sharply differentiated from that of the Council, the latter organization has little opportunity to manifest interest in the work of A.A.E. in any definite or material way. Conversely, A.A.E. does occasionally have opportunity to lend aid in special activities of council. It has, we believe, always been clearly understood that American Association of Engineers is ready to cooperate in any possible way, as it did for instance in the campaign sponsored by American Engineering Council for reorganization of the executive departments of the national government and coordination of all public works activities in one department.

Since the Founder Societies in 1920 created the Council, divided the field of activity, and also the resources that support the two kinds of professional activity, it would seem that they have a moral responsibility for the continuation of this agency. If instead of forming a separate organization, the Founders had put equivalent support back of A.A.E., this organization might well have carried both types of responsibility.

It was not as Mr. Hammond suggested in his letter, published Sept. 12, because "we felt that we could better work out our destiny alone" that we did not join the Council. The decision was not ours. The field was divided. American Engineering Council was created to take over a portion of A.A.E.'s original field.

American Association of Engineers proposed in 1920 that the Council make constitutional provisions that would enable A.A.E., when it so desired, to donate sums of money for support of special activities of the Council in which A.A.E. might be specially interested. The Council held that no special provision could be made for such participation, and that A.A.E. had the simple alternative of joining on the same financial basis as other societies participating in American Engineering Council or restricting its cooperation to projects not involving donation of funds.

Abandonment now will raise a question in the minds of many engineers as to whether the Founders entering on non-technical fields of activity in 1920 really intended to occupy or merely preempt the field. Will there be further diffusion of energy and funds, eventual futility and abandonment of the fight for better compensation, stricter licensure, stronger civil service, stricter codes of ethics, because dozens of agencies engage independently in work that requires unified support by the whole profession—substituting many relatively impotent agencies for a single effective body? Must we let the other portion of welfare work be divided and redivided until eventually it stands in the unhappy position of American Engineering Council today?

M. E. MCIVER
National Secretary
American Association of Engineers

A reader who signs only his initials sends back to us an editorial page from the Aug. 15 issue on which he has underscored the last words of the editorial concerning American Engineering Council which said that before the Council is abandoned it should be "permitted to demonstrate what it can do in the way of keeping engineers informed as to what it sees and hears in Washington." That, says this reader in a marginal note, "is the function of engineering journalism."

We agree, as is evidenced by the fact that the McGraw-Hill Publishing Co. maintains a staff of reporters in Washington. But no journal can keep its readers informed in as much detail as is necessary or always in the manner best suited to their needs.

For example, *Engineering News-Record* might report that a bill seriously affecting the status of engineers in federal civil service had been introduced into Congress. That news broadcast over the country gives engineers in federal service warning, but from there on the "listening post" in Washington can be of most help to them as it can report to interested groups, by telegraph if necessary, the progress of the legislation, chairmen of committees to which the bill has been referred and proposed changes that develop in committee hearings. These are details that may not be available when the engineering journals go to press and a delay of a week in putting them in the hands of interested groups may be fatal to effective action. Both the engineering journals' reports and the detailed follow-up by the engineers' representative in Washington are essential if engineers are to be heard in matters of direct concern to them.—EDITORS.

EDITORIALS

VOLUME 125 NUMBER 15

October 10, 1940

It Will Have to Be a Long War

THE WAR WILL HAVE TO BE A LONG ONE if some of the projects that are now being dusted off and brought forward as defense measures really do what is expected of them. Thus we have reports from Ottawa that agreement may be expected any day on the long-proposed treaty for development of the international section of the St. Lawrence River for power and navigation. We are told that the power is needed for defense industries. If more power really is needed from that river a large amount can be obtained much more quickly and cheaply by turning the water from the Hudson Bay drainage basin into Lake Superior, or by developing more power at Niagara or at the Beauharnois plant in Quebec. Old plants stand idle at Niagara that could be used in an emergency even at the cost of drying up the falls. In view of the billions that must be spent for defense measures, any effort to use defense as an excuse for constructing questionable projects should be strongly opposed.

Panama by Highway

OF THE MANY THINGS that will be done in the name of national defense in the days to come, few will be more justified than the loans to Central American countries to complete the Inter-American Highway, linking Texas and Panama. Two such loans, to Costa Rica and Nicaragua, have been made in recent weeks, and others are believed under negotiation. Recognizing the importance of such a road, the United States began limited aid about 5 years ago by building bridges at three of the larger stream crossings. These bridges were outright gifts made in the hope that they would stimulate the local financing and building of adjacent sections of the road, but progress since has been slow because the countries concerned lacked the money and even the incentive to go ahead on a big scale. And big-scale building is required in view of the fact that of the 3,200 miles involved only about one-third is paved and scarcely three-quarters is passable. A land route to Panama fits logically into the plan for hemisphere defense. The jobs provided local labor in the countries traversed and the money that will be spent locally by the international traffic that will use the new road fit into the objective of giving economic aid to Latin America. And finally, to top these arguments, the loans will be secured by gas taxes on the commercial and pleasure traffic generated by the road which experience indicates will be of large volume. In this instance at least national defense has stimulated a project that is eminently sound for either peace or war.

Tin-Can Building

SPECIAL-PURPOSE BUILDING DESIGN rises to a unique level in Le Tourneau's recent shop extension, beyond question the most extreme application of sheet metal to structural building service yet made. Framework is boldly discarded; the shell constitutes its own frame, for the walls and roof are nothing more or less than tin cans, assembled and grouped by welding instead of soldering. Structural shapes appear only in the sills and some minor posts. Details aside, the frameless principle embodied in this shop building claims close attention on the score of originality. It may show the way to a useful new type of building framing.

Building up a Headache

REPORTS ARE CURRENT that some manufacturers are financing contractors holding national defense jobs by renting them new construction equipment. Since the government has awarded the job on the basis of renting the contractor's equipment at so much a month, the transaction looks attractive to the manufacturer. In effect, he reasons, he is selling the equipment to the government on the installment plan. And Uncle Sam is sure pay. A little reflection would show it is not so simple as that. For one thing the manufacturer is tying up working capital that should be employed in his business, but most important is the fact that the government, under certain conditions, can terminate the contractor's job on short notice. Should that happen the manufacturer owns some secondhand equipment. Also the chances for the job to be terminated are probably better than average since the contractor who cannot finance his own equipment is the one most likely to create the "certain conditions" under which the government takes action. In the past manufacturers who have attempted to increase sales by going into partnership with contractors have too often only succeeded in launching

a poor contractor. And they have acquired a headache for their pains. There is little in the present situation to indicate that it is free from the possibility of similar headaches.

Pavement Scaling Solved

DISCOVERY OF MEANS for controlling the scaling of concrete pavements, reported in this issue by O. L. Moore, makes an important contribution to concrete construction. It assures practical progress by enabling the roadbuilder to produce scale-resistant surfaces, and improves our understanding of concrete.

Ever since scaling troubles followed on the use of salt and calcium chloride to thaw ice from pavements, concrete men have been perplexed by the observation that some natural cements conferred greater resistance than portland cements, though the latter are stronger. Naturally, question arose about the possible influence of chemical composition, fineness and setting time. These uncertainties disappear now that the effect has been traced to bits of tallow in the grinding mill. Continued study of this action should show how scale resistance is connected with the structure of the concrete, its porosity, or perhaps to the more intimate contact of its component particles, and thus help to place the big problem of durability under control.

A significant feature of the reported results is the relation between scale resistance and workability. The concrete that proved to be most scale-resistant was also the most plastic and placeable. Thus the gain in durability entails no countervailing loss of useful qualities. In fact, the improved workability may be valuable even where scaling is not at issue.

Accelerated tests often are discounted as not duplicating service conditions. The present tests, however, utilized natural or service actions, though under more careful control than could be obtained in routine highway service and merely repeated these actions much more frequently than would normally be the case. The results, therefore, should be conclusive. Nevertheless the several scaling test roads built during the past year or two—including that at Storm King, reported in our Sept. 26 issue—will be of great interest and can hardly fail to bring added knowledge.

Dynamite in Rising Prices

DESPITE REALIZATION of the futility of using words to buck the law of supply and demand, which is to say rising prices in the face of scarcity, this editorial is about prices. Its purpose is merely to call attention to some of the consequences of rising prices and to emphasize that price advances are not going unnoticed in Washington.

In the first place the academic period of merely talking about prices as an economic phenomenon is passed. Washington officials—and these include responsible business members of the Defense Commission—have begun to point out that there are ways available to control prices when necessary. The hint has been dropped that publicity regarding price rises can be very embarrassing to a manufacturer, and the Commission has given a dress rehearsal of the theory by a mild rebuke to the lumber industry. There are progressive steps beyond publicity but they are not important in detail since authority to exercise complete price control is already in the President's hand under the National Defense Act of 1916, which is in force whenever "war is imminent." Control of one kind or another can thus be turned on at will.

On the score of efficiency alone such governmental interference is to be avoided. Furthermore, not only the control but rising prices themselves hold a serious threat for business in a period such as this. Business, it should be noted, is not only on the selling end of national defense; as taxpayer it will also have to foot the bill. Selling the government something at an inflated price means only that taxes must be increased to cover it. Then there is the matter of inventories at the end of the emergency. The higher the price at which they were laid in, the greater the loss on liquidation. A third consequence of steeply rising prices is to freeze out private construction, particularly housing, and this would mean more government spending and still higher taxes.

Plainly there are good reasons for everyone to want to keep prices down, and cooperation with government efforts to put a ceiling on prices should prove a wise course. The alternative is rigid governmental control. One or the other—cooperation or control—must prevail, for with the government spending billions there is dynamite in inflation.

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Le Tourneau Builds Frameless Cellular Shop

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***Contents in Brief**—Hollow boxes 4x8 ft. made of pressed steel sheets welded together were used as units of roof and walls of a ¾-acre extension of the Peoria plant. The roof slab, 18 in. deep, spans 40 ft. between steel pipe columns, without girder support. The columns carry jib cranes and inclose pipe and wire services.*

BOLDLY DISCARDING PRECEDENT, the R. G. LeTourneau organization turned to welded cellular construction of sheet metal, without structural frame, for a ¾-acre addition to its manufacturing plant at Peoria, just put into service. Increased production made additional floor space necessary, and the governing considerations in providing it were speed, economy, and adaptation to the fabricating procedures used in the shop. Accordingly, the building was constructed entirely of pressed steel, prefabricated into the various shapes necessary to build the structure, and joined by electric arc welding. The flat roof, supported by 18-in. pipe columns spaced 40 ft. each way, consists of cellular panels 18 in. deep. The walls are made of similar panels 6 in. thick. Both walls and roof were made of units or panels 4x8 ft. in size, which made possible duplicate or production manufacture throughout.

The new building, 130x284 ft. in plan, is a southward extension of the old plant. It is 16 ft. high in the clear, has a flat roof slightly pitched to drain, and is lighted by windows in the upper half of the sides. Shop service is by jib cranes pivoted on the columns and arranged so that the whole area has crane service. Pipe and wire services are carried down through the columns to outlets in their sides; the electric supply wires extend across the roof over each line of columns on a series of short posts, and have leads passing down through weathertight fittings in the roof into the interior of the column. Pipes for water, compressed air, oxygen and gas are hung close under the ceiling and also run down inside the columns to the floor, where they branch out for outlet connections.

The cellular structure

Except for the columns the entire structure is built of 12-gauge copper-bearing steel. Each 4x8xft. panel consists of embossed inner and outer plates and a spreader and brace system between these plates made up of strips of 12-gage steel 1¾ in. wide pressed to shallow V-shaped cross-section for stiffness. A roof panel, sketched in Fig. 6, is typical of the makeup of both roof and wall. The spacer and bracing bars have about 40 per cent of their cross-section

Fig. 1. Welders connect pre-assembled units to form the shop wall.

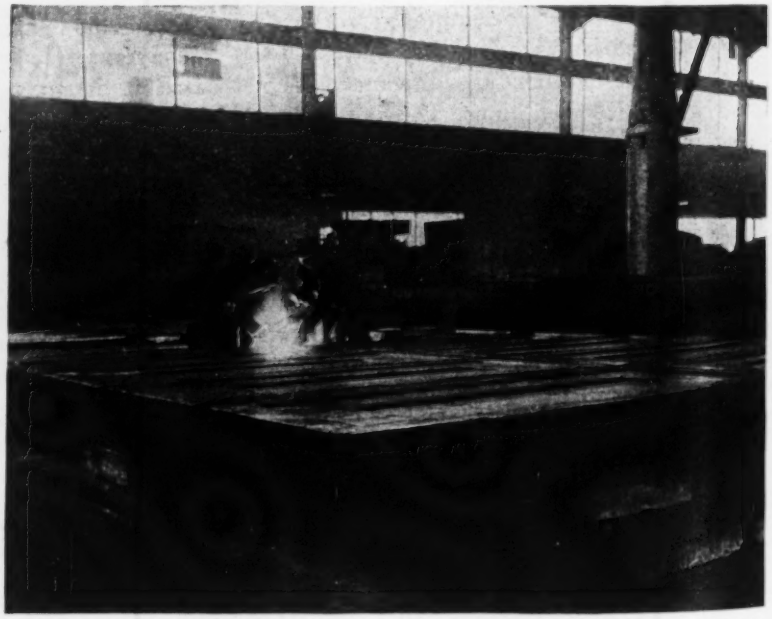


Fig. 2. A panel block being assembled for erection as part of the roof slab.

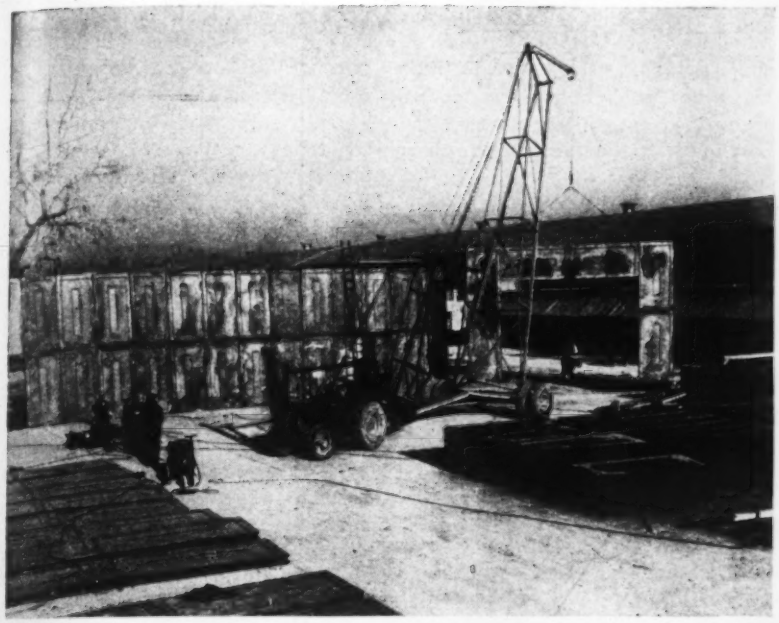


Fig. 3. Preassembled wall sections being lifted by portable tractor crane and placed in position on 30-in.-deep concrete footings. The lower outside corner of each lower wall panel is welded to an I-beam embedded in the footing

punched out in the forming operation to lighten them and to reduce the area available for heat transmission between outside and inside.

In assembling such a panel unit, the parts were positioned in a specially built electromagnetic jig that could open flat to horizontal position like a book. The two embossed sheets were positioned on the open leaves of the jig by means of stops and were held in position by electromagnets; then the jig was closed by pneumatic cylinders against stops which defined the final depth of the panel, and the spacer and bracing bars were positioned and arc-welded to the panel sheets.

The columns supporting the roof are lengths of 18-in. steel pipe with encircling bands welded on to form upper and lower bearings for the jib cranes. They have a ⅝-in. base and cap plates 24 in. square welded to the pipe and rest directly on the shop floor, without independent footings.

After clearing the site, formerly used for out-of-doors storage, and lev-

Fig. 4. Unobstructed floor space was obtained by supporting the roof slab on pipe columns spaced 40 ft. both ways.

eling and compacting the ground, wall footings 30 in. deep were excavated and concreted, as was also the 6-in. floor. Embedded in the footings and extending entirely around the periphery of the building, lengths of 6-in. junior I-beams welded end to end were set with top flange at final floor level; strips of steel welded to these beams anchored them to the footing concrete. To facilitate pouring the floor in sections, similar 6-in. I-beams were laid parallel to the sides of the building 10 ft. apart, and in the other direction 20 ft. apart, the whole network being welded at the junctions. These I-beams served as forms for the concreting, as reinforcement for the floor, and as ground for electric welding operations. They also assist in distributing the column loads, as each column is located over an intersection of these beams.

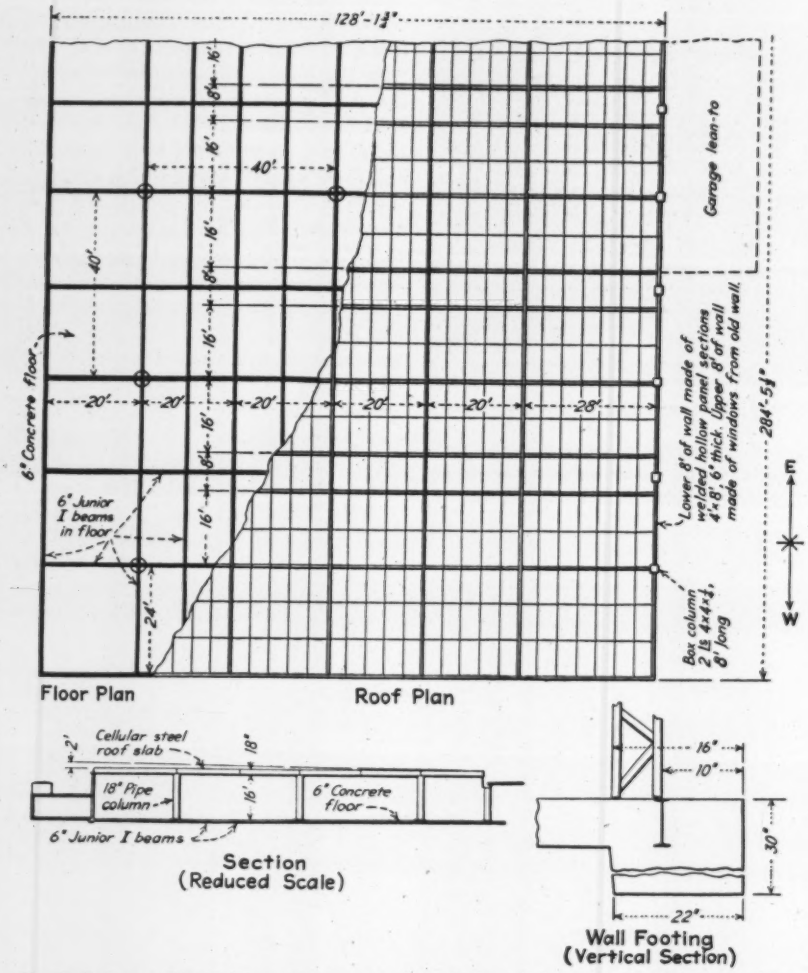
When footings and floor were completed, the wall panels were set in place on the footings and the lower outside corner of each lower panel was welded to the I-beam embedded in the footing. Similarly, the columns were set up, and the base plate of each column was welded to the floor I-beams. The wall panels were assembled into large sections on the floor, welded both sides, lifted to place by a portable tractor crane, and at once welded into a continuous wall.

Roof sections of various sizes up to 20x24 ft. were assembled on the floor and welded along all contacting edges top and bottom. Also, at each junction of four panels a plate 4x4 in. in size, with its corners lying on the joint line, was welded to the ceiling side as tension reinforcement of the roof slab.

These assembled roof sections, comprising from 7 to 21 panels, were lifted to position in the roof plane and supported on trestles. Sandwiched between adjacent sections vertical plates 18½x¼ in. were inserted, extending ¼ in. above the roof and below the ceiling, to strengthen the roof slab. These plates or webs were welded continuously to the roof and ceiling sheets of the abutting panel sections. Two such reinforcing webs intersect over each column and assist in transferring the roof load to the support. When the roof was completely welded it was covered with tar and gravel.

The upper half of one entire side of the building was fitted with steel sash glazed with hammered glass and equipped with pivoted ventilating sections. Along this side of the building the roof load is supported at 20-ft. intervals by box struts or columns fabricated by arc welding two 4x4x½-in. angles together.

When completely assembled and welded, the building was thoroughly buffed on its entire interior and exterior surfaces and given a coat of non-corrosive paint followed by a coat of aluminum paint.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McLaughlin Air Service

Fig. 1. Sewage disposal plant on Jamaica Bay, in south Queens, New York City, nears completion.

Forming and Concreting Sewage Tanks

***Contents in Brief**—Ingenuity and advance planning have produced an economical setup on forms and concrete placing for large diameter circular tanks and for aeration tanks at New York's Jamaica sewage plant. Light weight material is generally used in small units, easily handled without power machinery, to produce construction economies.*

CONTINUING ITS POLICY of providing for treatment of all sewage as rapidly as possible the City of New York is constructing a disposal plant south of Jamaica to treat waste going into Jamaica Bay. The plant consists of aeration tanks covering an area 250x320 ft., 12 sludge digestion tanks 80 ft. in diameter and 34 ft. high, 2 sludge thickening tanks 55 ft. in diameter and 8 final tanks 120 ft. in diameter and about 15 ft. high. Preliminary treatment is by means of fine screens, already in use.

Removal of a layer of marsh muck by a previous contractor left the area well below high tide and covered with a medium fine sand having sufficient bearing capacity to support the load of the filled tanks. An earth dike surrounding the site held out some of the water and wellpoints over much of the area, driven 25 ft. below El —3, kept the water out to El —14. Lowest excavation was to El —18. Four 8-in. pumps, seldom more than two operating at once, kept the 600x1000-ft. area dry.

General excavation over the site was done with 12-cu. yd. carrying scrapers with draglines finishing up at specific locations. As much material as possible was stored on the site for backfill, which was required nearly to top of completed tanks.

Planned forms

Careful planning, detailing and fabrication of forms has resulted in a rapid moving job requiring only a few men to handle the forms despite their unusual and circular shapes. Details of the aeration tank forms are shown in Fig. 2. Practically all of the lumber in this form is No. 1 spruce except the lagging, which is fir, covered with $\frac{3}{16}$-in. oil-tempered fiberboard. The form is made up in 4-ft. panels with 5 studs each and held by two 5000-lb.-working stress ties at each wale location.

Individual 4-ft. panels are stripped and moved, over the completed base, with the hand hoist shown in Fig. 4. The hoist is capable of handling 2,500 lb. on a 7-ft. radius and is mounted on a job-made frame for easy moving of the 700-lb. sections of forms. Double 2x4 wales are then added—continuous along the 42-ft. length of block. Each panel is scheduled for 16 uses, four sets of 42-ft. forms being provided.

A simple, easily stripped, interior circular form for sewage and effluent conduit is shown in Fig. 5. The form used for the invert is left in place and on it is set a prefabricated semicircular section made up of $1\frac{1}{4}$ in. spruce lagging covered with 24-gage black sheets and held in position with 5 ribs in an 8-ft. length. Four small wedges hold a top center filler

piece in position and leave an opening (covered by a narrow metal strip) to start removal operations. Knocking out the X-bracing and short circular piece shown in the foreground permits the entire form to collapse. Two carpenters with a helper set nearly a hundred feet a day.

Circular tank forms

Taking full advantage of the added rigidity curvature gives to materials the forms for the circular tank are constructed of very light, simple, members. Basic design is ⅝-in. plywood panels with six 3x4 studs to an 8-ft. length for both interior and exterior forms. Feature of the arrangement is 4-in. channels in about 12-ft. lengths, (see Fig. 7) bent accurately to the tank radius and used as inside and outside wales. Ties are 5000-lb.-working stress at 3-ft. centers in each of five lines of wales in the 14-ft. height. A test of the ingenuity of the form builder is provided by a peripheral effluent channel, with bottom elevation differing by 23 in. around the circle and requiring reinforcing steel placed with the wall. Forming the wall with reusable panels required accurate fabrication and skillful placing procedure. Each plywood panel is cut for a specific location, drilled for ties and numbered, then erection is started from the same control point for each use. The loose boards required for easy stripping of the trough section, where a large number of reinforcing bars protrude, are interchangeable in location and fit naturally into properly erected plywood panels.

Studs at each 8-ft. panel joint are erected first, being held in position by braces nailed to 2x6 pieces fastened to the concrete floor of the tank. Then the interior wales are erected and the rest of the interior studs set in position, followed by the numbered panels for the inside of the tank, each with a rip strip at the intersection to facilitate joining and stripping. Next step is placing of the reinforcing steel and the tying assembly, with

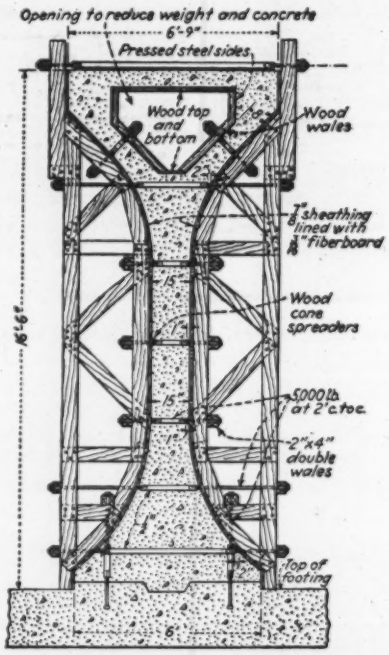

Fig. 2. Aeration tank forms.

spreader device, followed by closing in the exterior form. The kink here is to use a rod threaded at both ends in the assembled tying device, and to slip individual 4x8 panels over them. Studs are then erected followed by the circular channel wales, also slipped over the rods, and the assembly then drawn up with a threaded device on the rod. Location of radial lines is made from a rigidly built center tower designed to carry the concreting equipment later.

Circular mounted concrete chute

Concrete is purchased delivered at the site by truck mixers. For low-level pours and some isolated sections, trucks deliver into or near the forms but generally the concrete is brought to a central pump and distributed by pipeline to the locations required. Distribution to the aeration tanks is made from a pump-filled hopper into buggies which take the concrete to the forms. Note in Fig. 2 that a very small passageway is left for concrete and that puddling or vibrating is unusually difficult. This is believed to be the first major job in this area where the complete tank wall with cover over the top opening is placed in one operation.

For concreting the walls of the circular tanks the pump line is carried to the center of the tank at an elevation well above the pour and there discharges into a hopper on the swivel-mounted chute shown in Fig. 6. The swivel end of the chute is mounted on a rigid center tower and,

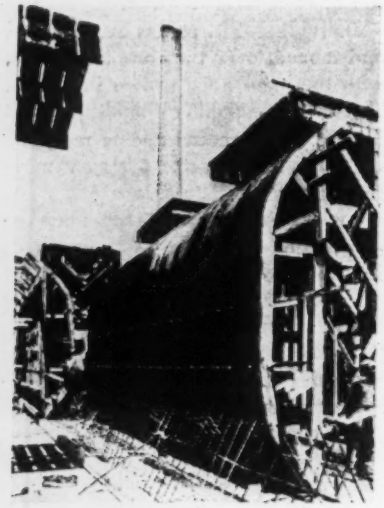

Fig. 3. One side of aeration tank form with ties inserted. Platforms are for buggy distribution of pumped concrete.

Fig. 4. A 4-ft., 700-lb. section of aeration tank form is carried at one time by this mobile hand hoist.

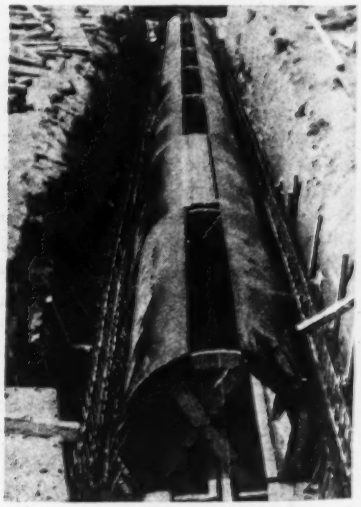

Fig. 5. Interior form for 42-in.-diameter influent conduit. Top section drops out to permit easy stripping.

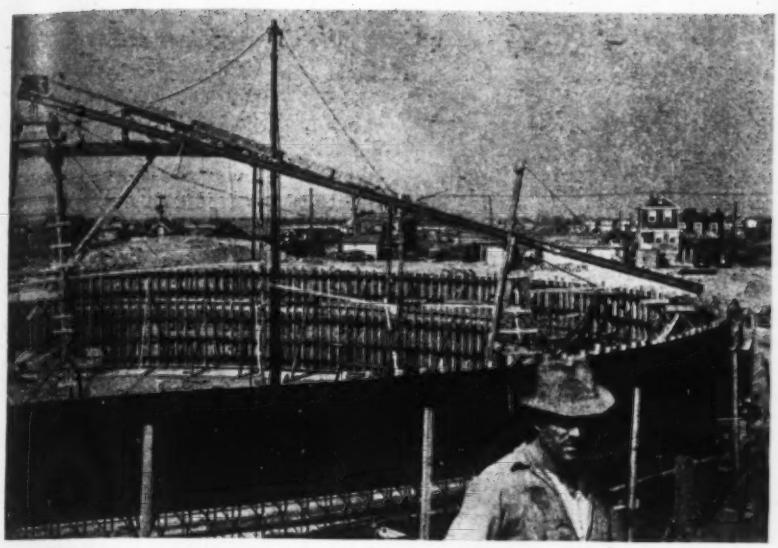

Fig. 6. Concrete pipeline supported by gin pole carries concrete to center swiveled chute whose outer end is mounted on a rubber-tired carriage. Inside wall of forms is erected first, then steel set and panels of outside forms slid into place over the form ties. Lag-threaded ties speed the assembly.

for the 120-ft.-diameter tanks, consists of a 48-in. trussed section of standard 14-in. chute and a straight 16-ft. piece. An A-frame supports the outer end at about the junction point of the chute sections, cables holding the discharge end just above the forms. The A-frame is carried on a pneumatic-tired four-wheeled carriage operating in a circle on the bottom of the tank. The walls are filled at about 2 ft. per hr., a layer around the entire periphery being placed in less than 1 hr. cycles to assure concrete without joints. The carriage is operated by hand, the "pusher" crew also tapping the forms to help consolidate the relatively dry concrete. Forms and placing methods for the digestion tanks are similar.

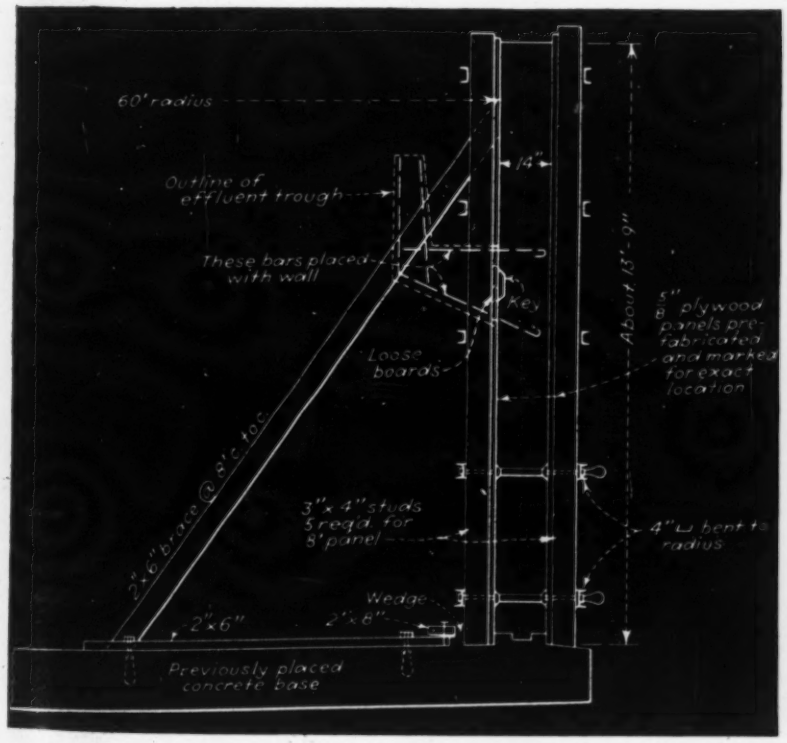

Fig. 7. Forms and concrete outline for circular tank walls at Jamaica plant.

The Geo. F. Driscoll Co., Brooklyn, N. Y., hold the contract for the tanks and equipment for the sewage plant, and are doing the excavation and draining of the area under direction of L. R. Miller. All concrete work is sublet to Moccia Construction Corp., Brooklyn. P. L. Moccia is in direct charge of the work and developed the forming and concreting schemes described. J. R. Torkildsen is superintendent.

Construction of the plant is under the jurisdiction of the Department of Public Works, City of New York, of which Irving V. A. Huie is commissioner, with R. H. Gould, acting deputy, and J. Frank Johnson chief engineer in charge of sewage disposal. For the Bureau of Sewage Disposal Wellington Donaldson is director, H. C. Gaffney director of construction, Henry Liebman designing engineer, W. A. O'Leary project engineer and W. Underhill in charge in the field.

Water Service Rates

During the last few years there has been a renewed tendency by both private and public water users to request special concessions on charges. According to Dale L. Maffitt, general manager, Des Moines, Iowa, water department, who addressed the American Water Works Association in Kansas City recently, granting of special rates and free water privileges must be made with caution for the following reasons:

Present large excess plant capacities or reserve supplies may be needed tomorrow.

Special rates once made are hard to rescind.

Revenue from water users should support the water department but public uses of water should be paid for by the taxpayers.

There is no such thing as free water in the sense that a plant once established can increase its output at only nominal expense.

All free water should be metered.

Expediency does not justify discrimination.

The general public should be made to realize that the operation of a water plant is a definite and distinct business in that it is called upon to furnish an adequate supply of water both for domestic and public consumption whenever the water is needed.

Columbia River Bridge Raised 45 Ft.

Contents in Brief—A through cantilever highway bridge, "The Bridge of the Gods," across the Columbia River just above Bonneville Dam is being raised 45 ft. to provide clearance required in the new plans for navigation. The suspended section of the main span was dismembered and removed in reverse erection order. Then the cantilever sections were raised on jacks as the supporting piers were progressively built up to required height. The cantilever arms were also inclined slightly over their original position, thus reducing the required jacking lift somewhat.

CONSTRUCTION of Bonneville Dam, 40 miles from Portland, Ore., and subsequent channel improvements in the Columbia River, made it necessary, in order that full navigation benefits be attained, to raise the level of "The Bridge of the Gods," a highway toll bridge of through cantilever type across the Columbia at Cascade locks, 4 miles above the dam. Most of the 45-ft. lift was made by jacking up the two cantilever arms and following them up with increased pier heights. However, approaches are simplified and total lift reduced by inclining the two cantilever arms slightly. The suspended section has been dismantled and removed; later it will be reassembled at the new grade which will give the required mid-channel clearance of 135 ft. above normal pool level.

The bridge was constructed in 1926 by the Wauna Toll Bridge Co., of Walla Walla, Wash., its present owners. It was designed for two 15-ton trucks, passing in the same direction with 30 per cent impact on hangers and floor system, plus a uniform live load of 1,200 lb. per lin. ft. on the cantilever arms, 1,600 lb. on the suspended section, and 2,200 lb. on the approach spans.

The total main bridge length of 1,127 ft. is made up of two side or anchor spans 211 ft. long and a center span of 705 ft. This center span includes two 235-ft. cantilever arms and a 235-ft. suspended section. Before Bonneville Dam was completed to final height, the piers of this bridge were brought up to a level 6 ft. above normal pool level, thus avoiding any subaqueous work in the bridge raising operations.

Lifting operation

In July, 1939, Congress voted funds for raising the structure as a part of the Bonneville Dam project. The lifting operation, now being done under specifications prepared by the Wauna Toll Bridge Co. and approved by the Army Engineers, divides itself into three steps. The first, comprising enlargement of the piers and bringing them above the new waterline, required about 5,000 cu. yd. of concrete. This work was finished by the end of 1938 at a cost of about $175,000. The second step included building new approaches, enlarging old concrete piers and constructing new abutments. This was begun in the latter part of 1939 and was completed before the end of the year, after which the job was shut down until spring. Neither the first nor the second steps required closure of the bridge.

The third step, begun early in 1940, comprises the actual raising of the structure and connecting it to new approaches on north and south sides of the river laid out to suit the new high waterline and inclined cantilever arms.

The possibility of raising the bridge bodily, without inclining the cantilevers and without taking down the suspended section, was considered. This plan would have increased the load on the jacks by a very considerable amount and extensive reinforcing would have been required in the main tower posts as well as in other parts of the trusses. Also, economies resultant from changing to inclined cantilever spans were a consideration.

With the suspended section out of the way, the plan of operation was to jack up opposite cantilever arms alternately in 7-ft. lifts. After each lift a 7-ft. pour of concrete was added to the pier height and, while the concrete was setting, the crew worked on the other pier.

The jacking operation was done with four 500-ton hydraulic jacks on each main pier and two of 200-ton capacity on each anchor pier. The anchor arms were loaded with the steel from the suspended span and with sufficient additional weight to give a downward reaction of 200 tons at each anchor pier. This arrangement assured positive control of the span during jacking operations.

Putting a 2 per cent grade on the cantilever arms affords a two-fold advantage: (1) less total lift and (2) access on an easier grade from the Columbia River highway. This inclining of the cantilever arms lengthens the suspended span slightly, necessitating new gusset connections at the junction points. These changes are being made while the suspended span is down. Another change is new shoes for the cantilever arms. How-

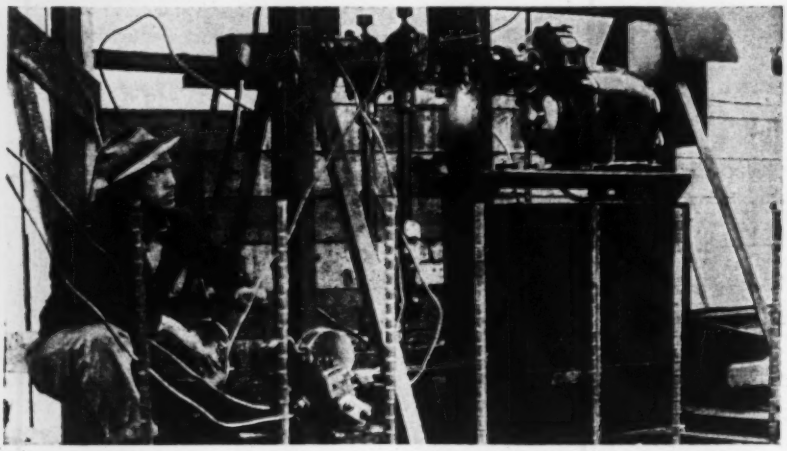

Fig. 1. Pressures in the 500-ton jacks were watched carefully as lifting progressed.

ever, in general the changes are minor, and analysis shows that the inclination will not materially affect stress distribution in the bridge members. Approaches to the new position of the anchor arms require a 3 per cent grade on the Oregon side and 4½ per cent on the Washington side. Both approaches were practically level before the raise.

The grade and increased height on the Washington side made it advisable to use a new and heavier approach truss. This is shown in process of erection in Fig. 3, using the original approach truss for erection purposes.

The work is being done under the general supervision of the U. S. Engineer Department, Col. John C. H. Lee, division engineer, Maj. R. H. Elliott, district engineer. Plans and specifications were prepared under the direction of Chas. G. Huber, engineer for the Wauna Toll Bridge Co. The contract amounting to $438,543 for completing the alterations is held by the Tavares Construction Co., of Los Angeles, California.

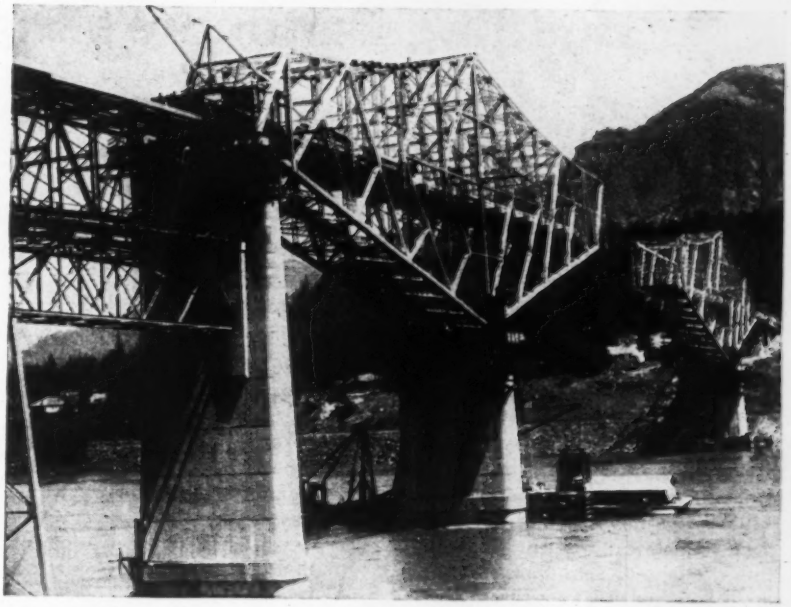

Fig. 3. It was necessary to close the bridge to traffic because the suspended section of the main span had to be removed temporarily. The contract called for the bridge to be reopened for service within 120 days after being closed. With the suspended section removed cantilevers were raised and inclined. Former deck level is indicated by old approach truss at left.

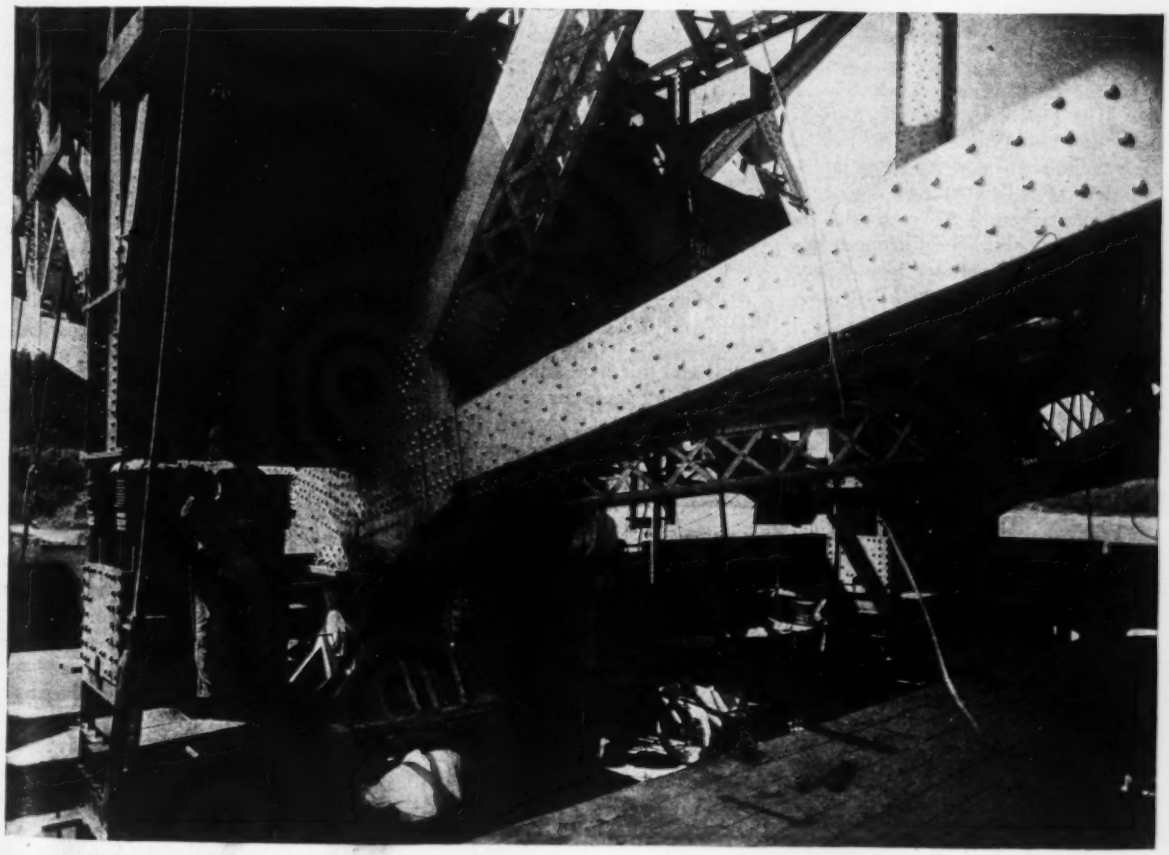

Fig. 2. Two jacks under each end of a temporary lifting beam raised the bridge in 7-ft. lifts. The grillages under the shoes were concreted in but those under the jacks were removed prior to each pour.

Building Baltimore's Big Tunnel

John J. Hunt and Bernard L. Werner
Construction Engineer and Assistant Construction Engineer
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***Contents in Brief**—Installation of diesel power unit totaling 2,720 hp was the first step taken by the J. F. Shea Co. in the construction of the Baltimore water tunnel. What followed in the way of drilling, mucking and lining the 7-mile conduit forms the substance of this article on procedure in tunnel building. Design and hydraulic features of the project were published in ENR, Sept. 12, 1940, p. 346.*

NOT THE LEAST of the many interesting construction features involved in building Baltimore's new pressure water tunnel was the installation of 40-ft. sections of steel lining each of which weighed 16 tons. The 7-mile conduit with a finished bore of 12 ft. was blasted out of rock, and for two-thirds of its length is concrete-lined. The remaining 12,000 ft. is lined with continuous welded steel plate.

When work was started on the project in April, 1937, it was decided to carry on tunneling operations from four bases (Fig. 1). One was a portal at the north end near Loch Raven Dam. The others were a 165-ft.-deep shaft at the Montebello filtration plant at the south end, and two intermediate shafts. The latter (Louise and Miller shafts) were 220 and 210 ft. deep, respectively. The distances between bases was about two miles. There was a total drop of 110 ft. between the ends of the tunnel.

To provide power for the operation of machinery and tools the contractor negotiated with the local power company. However, due to the inability to agree on rates satisfactory to the contractor, he decided to generate his own power using diesel equipment.

From the portal the contractor worked south; from the Louise and Miller shafts work progressed in both directions, and from the terminal shaft at Montebello the work moved northward only, thus making six separate headings in operation at the same time. At the two intermediate shafts, the drilling and blasting was done in one heading while muck was being removed at the opposite heading. The time required to complete a cycle of operations averaged 3 hr. of drilling, 1½ hr. of blasting (which included loading and waiting for the tunnel to clear of smoke) and 3½ hr. for mucking.

Diesels supply power

Air compressors, blowers and generators driven by 15 diesel engines were installed by the contractor at the portal and the three shafts. The blowers pumping fresh air into the tunnel were each of 5,000-cfm capacity. The 250 volts d.c. electric current for lighting and operating equipment was generated by means of nine 125-kw generators, directly driven by diesel engines. Fourteen of the diesel engines were 180-hp units and the remaining unit was 200-hp (Fig. 2).

Air requirements were supplied by stationary compressors, belt-driven by the diesels. At the Louise shaft two compressors were used with a total capacity of 2,200 cfm, as well as a 360-cfm unit connected up as an emergency standby. A similar compressor hookup involving two units of 950-cfm capacity each and a 360-cfm standby took care of air requirements at the Miller shaft. For the single heading at the Montebello shaft and at the portal, each of the surface plants are equipped with a 1,150-cfm compressor, and a 360-cfm standby unit.

A steel headframe and an elevator cage operated by a single-drum mine hoist powered by an electric motor was erected at each shaft. On the surface at the Louise shaft were the machine shop and drill forging shop for the entire job. The sharpening equipment included three oil-fired heating furnaces with pyrometric controls; three drill forging machines, air-powered; and two oil-fired heat treating furnaces, equipped with automatic pyrometric controls.

Handling the drill steel

Drill steel from the six headings was delivered on flat cars by truck to the forging shop. The cars were run off the trucks onto the tracks of an inclined loading ramp. Here the steel was transferred to hand trucks and taken into the shop. After being sharpened, the steel was placed according to length on the proper hand trucks and from here manually loaded on the railway cars; each car was stocked with enough steel for a complete round of drilling with the longest steel placed on the bottom of the car and the shortest on top.

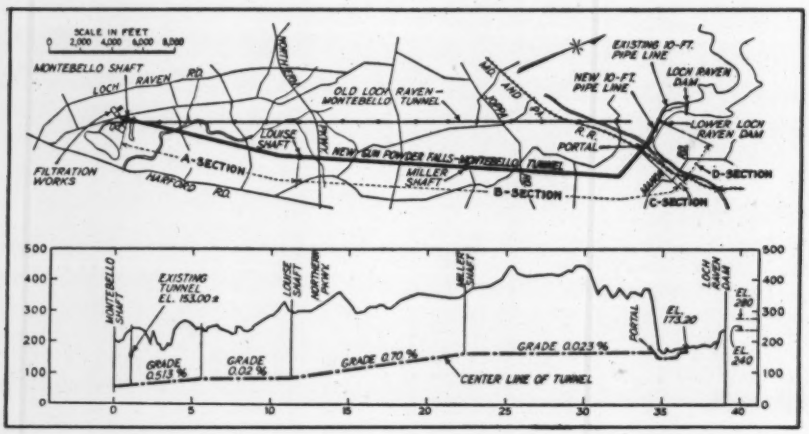


Fig. 1. Line of the old and new tunnel routes and location of construction shafts.

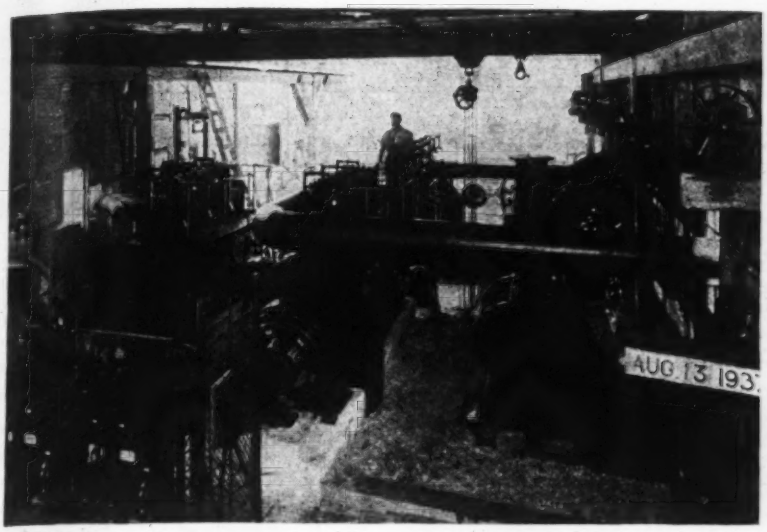


Fig. 2. Diesel-driven generator and compressor plant at the portal is typical of that used at the three shafts. 15 such diesels are in use on the project.

About 4,000 drill steels were the maximum number sharpened in 24 hours. The loaded railway cars were pulled from the platform into motor trucks with power winches. The steel was not touched again until it was lifted off the cars by the driller's helpers in the heading. Starting drills were 2 ft. long and the longest steel used was 13 ft.

Drilling procedure

In driving the tunnel, a full face was pulled in all headings. The drilling procedure depended upon the shift foreman's preference as to where the holes were to be placed and how many were to be used, this varying according to the character of the rock. An ordinary round consisted of holes 11 and 9 ft. in length. Cut holes were usually drilled with 11-ft. steel, and relief, line holes and lifters with 9-ft. steel. Where shifters used only V-cut holes, the drilling was done with 11-ft. steel and the number of holes from 5 to 7, although on some shifts 2 to 5 holes additional were drilled. In cases where "soft" ground was encountered, the rounds at these points were reduced to 7 ft. and sometimes to 5 ft. The number of relief holes varied from 14 to 21 and the number of line holes and lifters from 14 to 23.

The average number of holes drilled in the various headings ranged from 44 to 48 per round. Each round required the drilling of more than 450 lin. ft. of holes. Drilling time for a full round was from 2½ to 3½ hr., depending upon the hardness of the rock and the working conditions at the face. The average drilling speed was 0.45 to 0.60 lin. ft. per min. for each of the drills, excluding the time for setting up. The automatic drills, mounted on a jumbo drill carriage, were powered by air. Each carriage held 5 drills.

Typical loading for a 9-ft, round was 320 to 340 lb. of 60 per cent gelatin dynamite. Rubber blasting plugs were used for stemming and the holes were fired with 10 delays. Such a round usually pulled 8 ft., the breakage averaging about 7 cu.yd. of rock per foot, thus requiring about 6 lb. of explosive per cubic yard dislodged.

Mine cars for muck

Broken rock was loaded by electric-powered mucking machines into steel mine cars which were hauled out of the tunnel by combination electric trolley and storage battery locomotives. The hauling track was 45-lb. rail set on a 36-in. gauge.

Each 8-hr. shift was scheduled to complete a full cycle of operations (mucking, drilling and blasting) but delays cut down this average to about 2½ shots per day in each heading. The rock excavated was very hard and little timbering was necessary. In the length of 7 miles, only 140 ft. at the portal entrance and a total of 700 ft. at eight other widely separated places, required supports. The rock spoil was hauled to private property which the contractor rented, the haul averaging about ½ mile.

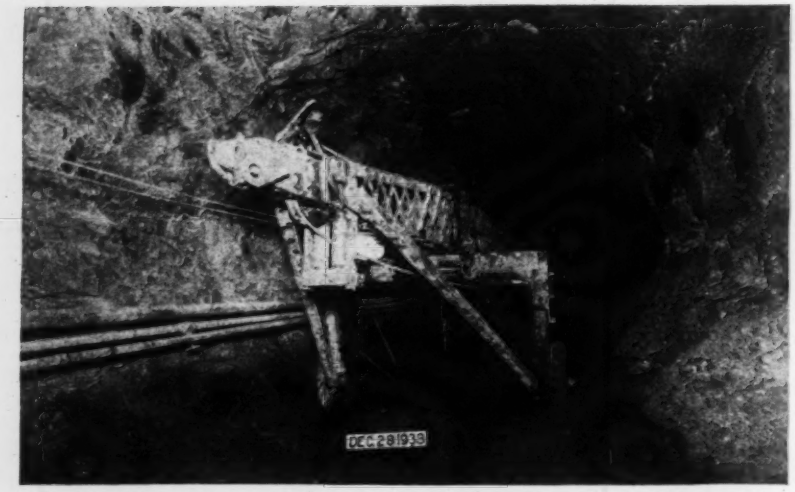
Upon completion of the excavation, the 18-in. 12-gauge spiral steel pipe used for ventilation was taken down and the entire tunnel marked for tight spots. This was done by using a template having flexible steel rods extending to the minimum rock line. Wherever these rods bent from their original position as the template moved through the tunnel, thus indicating tight spots, the rock was painted for the contractor to drill and blast.

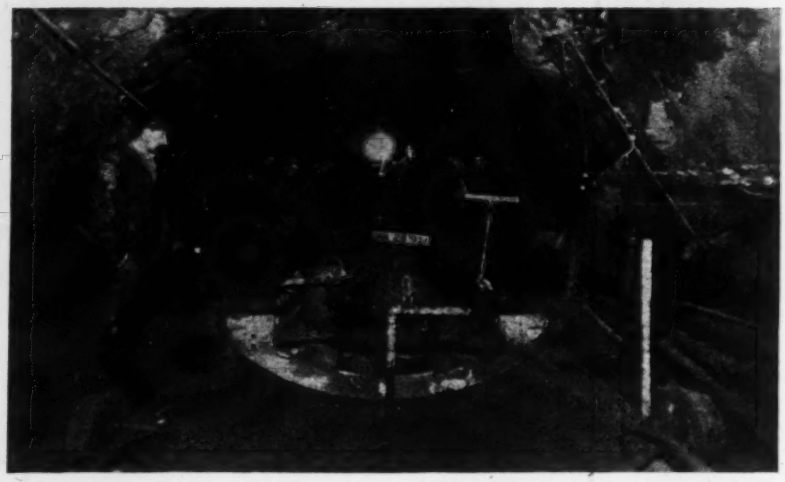
Before concreting began the bottom was cleaned by using a tunnel drag scraper (Fig. 3) augmented by hand cleaning where necessary and finally blown with air and water. This scraper consisted of a boom about 40 ft. long attached to a mucking machine, running on tracks at the forward end, and trailing on wide-gauge rubber-tired wheels at the rear. In operation the tracks and ties beneath the boom were first taken up. The drag scraper was then passed back and forth beneath the boom, scraping the muck toward the mucking machine where it was picked up by a conveyor belt and loaded into cars. The dragline was arranged with guide braces extending outward and downward from the boom so as to have the drag cover as much of the tunnel bottom as possible. It was then necessary to relay the tracks for concreting.

How the concrete lining was done

About 22,000 ft. of the tunnel construction is of mass concrete of a 1:6 mix, lightly reinforced with ½-in. steel bars against temperature stresses. In this section three different operations were used to complete the finished lining. First, curbs were poured along each side for the purpose of supporting the sills that fixed the elevation of the invert and provided means for supporting the screed which formed the finished invert. The curbs were set on line and grade and their position fixed the final alignment and grade of the completed lining structure. Concrete for the curbs was delivered by transit-mixed trucks and transported by side dump cars to the forms.

The second step was the pouring of the invert. The material for the concrete was delivered in the tunnel in dry batches to a combined 1½-cu.yd. mixer and concrete pump which was located on tracks about 150 ft. ahead of the screed. In the space between the screed and the concrete pump the tracks were removed, the bottom





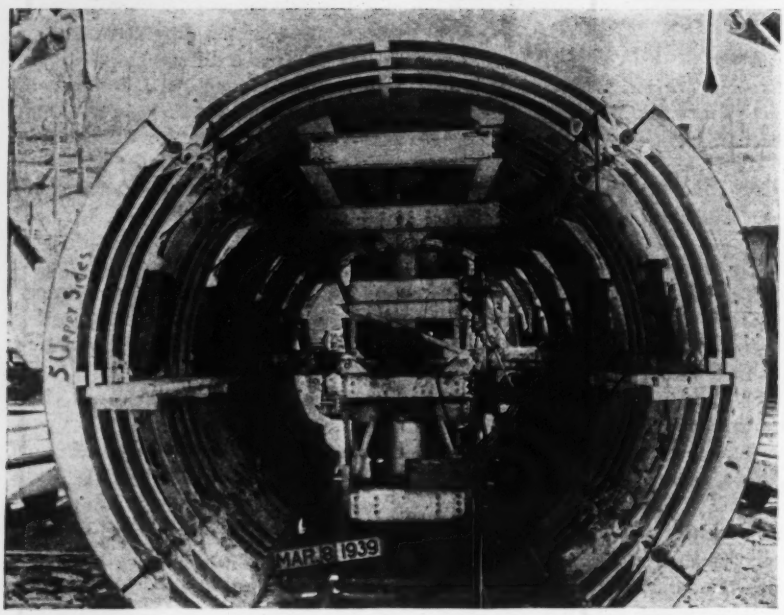


Fig. 3. Construction equipment: (top) dragline scraper used to clean bottom prior to concreting curbs; (center) screed used for forming invert; and (bottom) a 40-ft. section of collapsible steel form supported on transport carrier.

blown with air and water and the reinforcement placed in position. The discharge pipe from the pump was carried back to the screed, and concrete was pumped in the required amount and consistency. The screed was very heavy on its front end and was moved on rails by means of an air tugger, in either direction as required. The invert screed formed a section of the finished lining 78 deg. in extent. The final finish of the invert was done by hand, the finishers working on a light traveler from which they could reach all portions of the invert without stepping on the green concrete.

Forming the tunnel arch

The final operation was that of forming the tunnel arch. This was accomplished by using a specially designed steel form, consisting of 20 sections, each 8 ft. long (Fig. 3). Each section was hinged at four points. Access doors, with means for ready closure, were provided in each section. Five sections of arch form were moved at one time by a form carrier under its own power. This carrier was fitted with hydraulic jacks for pulling in the sides of the forms and raising or lowering two 30-ft. I-beams, which supported the forms while moving.

All concrete for the arch was pumped in back of the forms on a 1:3 slope, the discharge pipe being buried under the concrete anywhere from 10 to 15 ft. and slowly withdrawn as the form filled (Fig. 4). Where the opening between the rock and form permitted, a man was placed on either side to work the concrete against the form; pneumatic hammers were used to vibrate the forms. An average pour was about 315 cu.yd. in 16 hr. This filled 158 ft. of forms, there being a 2-ft. overlap on each pour. Under a normal working schedule five pours of arch section were made each week.

To insure the filling of all voids, the contractor was required to grout behind the lining. After the concrete had set for 30 days, grout holes were drilled every 10 ft. along the centerline of the tunnel and into these was pumped a 1:2 cement grout under 100-lb. pressure. To seal weeper pipes from pans put in while concreting, the contractor grouted these pipes with neat cement under 235-lb. pressure.

The steel-lined section of the tun-

nel extended from the Montebello shaft to the Louise shaft, a distance of a little over two miles, and also included a 400-ft. section at the portal end of the tunnel. In concreting these last two sections, no reinforcing steel was used, nor was a segment of a circle used for an invert. Instead the invert was poured flat with an 18-in. gutter 6 in. deep in the center as a waterway so that the drainage would not interfere with the electric welding of the circumferential joints of the steel pipe. The concrete for the invert and arch in the steel-lined section, was a 1:7 mix placed by the same methods as previously described.

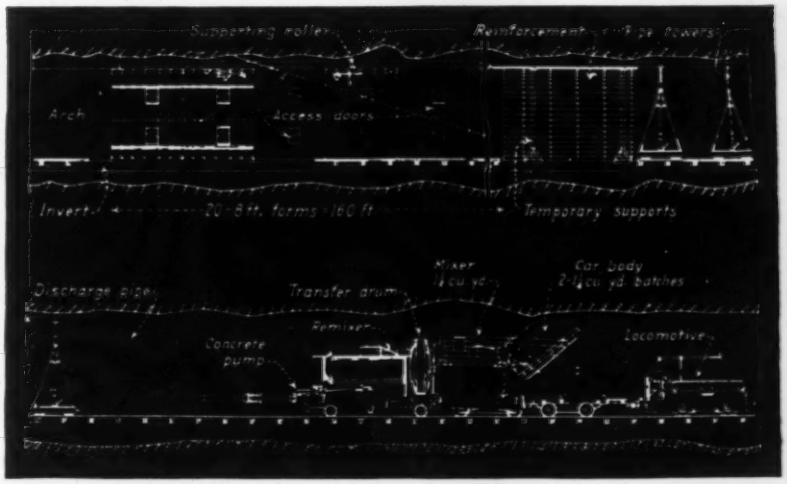


Fig. 4. Concrete pumping plant and forms set up for tunnel lining operations.

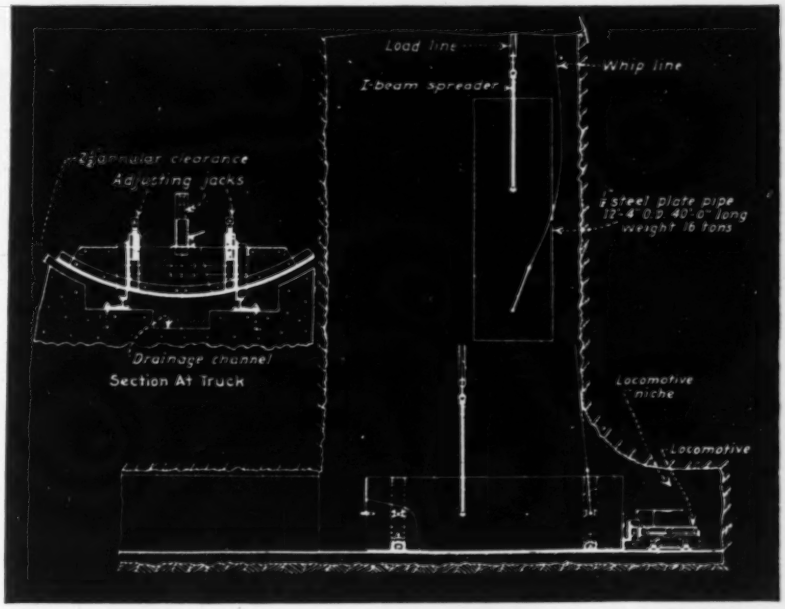


Fig. 5. How the 40-ft. steel liner sections were lowered into the tunnel and transported into place.

Placing the steel lining

The concrete arch was poured so that there was an annular clearance of 2½ in. between it and the outside of the steel pipe. This small clearance, together with the fact that each steel pipe was 40 ft. long and weighed 16 tons, presented a rather difficult job of placing the pipe, which was done by the Bethlehem Steel Co. under a subcontract. How this was accomplished is shown diagramatically in Fig. 5. A stiffener ring and truck assembly was first placed in each end of the pipe. The pipe was then picked up by a bridle sling and lowered vertically down the Montebello shaft, all of the weight being taken by the main hitch until the pipe was near the bottom of the shaft. At this point a strain was taken on a whip line fastened to the pipe near the bottom end, the effect of which was to change the pipe from a vertical to a horizontal position, as shown.

The truck wheels projected through slots cut in the bottom of each pipe within the stiffener rings and the landing of the pipe on its wheels on the track was done very quickly once the pipe was in a horizontal position at the bottom of the shaft. The manner in which the trucks were suspended within the stiffener rings permitted the trucks to adapt themselves to minor irregularities in the track. The front end of each pipe section was provided with a backing-up strip on the upper edge and a similar strip was fixed on the lower end of the pipe previously placed; by this arrangement the alignment of the pipe was readily accomplished, the hydraulic jack screws that were part of the truck construction being used for this purpose.

In order to minimize the swaying of the pipe and to prevent it from binding against the concrete, guide wheels which ran against the concrete arch were fixed to the front end during the transporting of the pipe, and removed just before the pipe was brought in contact with the one previously placed. Prior to placing a length of pipe, the track bolts for about 40 ft. were removed; the front end of the pipe was then set to the pipe previously placed and supported in position on the rear end. The rails projecting beyond the newly placed pipe were burnt off and withdrawn from under the pipe, leaving the space beneath it free for the movement of the grout, which was pumped into the annular space outside the pipe. The track was later relaid inside the steel pipe for use in transporting the Gunite materials.

Lining bulged by groundwater pressure

After the welding of the circumferential joints of six or seven pipes was completed, a bulkhead of cement blocks was constructed around the pipe. A 1:2 cement grout was then pumped through 2-in. holes located in the top and sides of the pipe.

In the steel-lined section of the tunnel considerable trouble was experienced by bulges occurring in the steel pipe after the grouting was completed. These occurred as a result of groundwater pressure building up to a point sufficient to collapse the steel pipe inwardly. These bulges occurred at 10 different places in a 3,000-ft. section of the tunnel. The length of the bulges averaged about 36 ft. and the deflection averaged 15 in. In these cases it was first necessary to cut access holes through the pipe so as to remove the grout, jack the pipe back into position, secure it with anchor bolts, and then weld plates over the openings and regrout.

Bulging solved by check valves

Considerable attention was given to means of overcoming these difficulties, and as a result it was decided to meet the condition by the installation of 1-in. bronze check valves, located where necessary in the affected areas. These valves will permit the infiltration of groundwater when the tunnel is unwatered and the checks will prevent any outward flow of water when the tunnel is under pressure.

The steel pipe section of the tunnel is protected against corrosion by a 1½-in. Gunite lining, shot on a wire mesh reinforcement. This mesh, spaced on 3-in. centers and composed of No. 10 gage wire is held in place by ⅜-in. reinforcement bars, placed on 3-ft. centers and tack-welded circumferentially around the interior of the pipe. The lining was applied in 2 coats, the first layer being shot through the reinforcement and built up to but not beyond the mesh, and the second layer brought to the thickness required. After the lining was screeded the screed rings, which were 6 ft. center to center, were removed, and a flash coat applied. The final finish of the lining was accomplished by wet-brushing the surface in a horizontal direction.

Lining materials were mixed by means of a continuous mixer, supplying two cement guns. Two nozzlemen worked from the guns simultaneously about 200 ft. apart. An average of 600 ft. of finished Gunite was applied weekly.

Pipe in open cut

Connecting the tunnel proper from the portal to the old tunnel is a 10-ft.-diameter steel pipe about 1,900 ft. in length. This pipe was installed in open cut and is protected with a concrete casing on the outside and a bitumastic enamel on the interior.

Prior to coating the interior of the pipe with the bitumastic enamel, the piped had to be freed of all scale, which was accomplished by shot blasting. This was followed immediately by the cold application of a primer coat of a bituminous solution and the pipe was then ready to receive the final hot application of enamel.

In order to deliver the water to Baltimore's two filtration plants, as well as to unwater the tunnel, special construction was necessary at the Montebello shaft. This work included the building of a vertical 12-ft. steel pipe, encased in concrete and gunited inside, a control vault 73x42 ft., and two valve vaults housing 60-in. valves, together with a 240-ft. bypass tunnel and shaft house. This work is almost completed but because of the many details involved, it is not expected to be entirely finished before the end of the present year. However, it is expected that the tunnel will be in use by Dec. 1, 1940.

Direction

The Baltimore tunnel construction is under the direction of the Bureau of Water Supply of the Department of Public Works. George Cobb is chief engineer and Leon Small is water engineer. C. J. Kavanagh is superintendent in charge of construction for the J. F. Shea Co., Inc., of Los Angeles, Calif., general contractors on the job.

Absorptive Form Lining Specified For Wyoming Underpasses

ABSORPTIVE FORM LINING has been specified for the first time by the Wyoming state highway department for grade crossing elimination underpasses at Rock Springs and Casper, for which contracts have just been let. The form lining is called for on all exposed concrete surfaces, and can be used only once.

Detailed specifications covering the type of lining to be used were written after a series of tests had been completed for the highway department by the U. S. Bureau of Reclamation at the Denver laboratory. Highway officials were enthusiastic over the results of the tests, and if results obtained in the field equal those in the laboratory, the absorptive forms for exposed surfaces will probably be specified on all future structures.

In general, the Wyoming specifications follow those issued by the Bureau of Reclamation for Friant Dam. The form lining must be capable, through its absorptive capacity, of eliminating voids to the extent that not more than 2 per cent of the surface area shall contain any defects. The test for this qualification is to pour concrete against a 3 x 5-ft. area of the form. The resulting concrete surface is marked off in 2-in. squares, and any square containing one or more surface voids larger than ⅛-in.-diameter will be considered as objectionable area. The sum of all such areas must not be more than 2 per cent of the total test area.

The lining must be capable of withstanding, when wet, the load of 12 ft. of 4-in.-slump concrete without deforming, must withstand normal handling without damage, and must be "reasonably free" of hairy or fibrous material that would stick to the concrete. Specifications require that not more than 5 per cent of the form surface may stick to the concrete upon removal, and that which does stick must be easily removed with a putty knife. Material that discolors or reacts unfavorably to concrete will not be permitted.

Tests and resultant required values for tensile strength, transverse strength, deflection, linear expansion and absorptive qualities are also specified. Form material must be single ply, except that a special surface coating is permissible, and must be furnished in sheets ½ in. thick and at least 4 x 6 ft. in size. Edges must be square. Finally, the forms must pass an actual performance test before the material will be accepted by the highway department.

Frank Kelso is superintendent of the Wyoming state highway department; C. F. Seifried is chief engineer. W. H. Fisher, bridge engineer, and I. E. Russell, materials engineer, have supervised the tests and prepared the specifications.

Pavement Scaling Successfully Checked

O. L. Moore
Director of Tests and Research
Universal Atlas Cement Co., New York

***Contents in Brief**—Study of concrete scaling caused by use of chlorides to clear icy roads led to the discovery that minute amounts of grease in the cement account for the superior resistance of some concretes. Further laboratory work indicated that scaling could be prevented by grinding a rosin product into the cement. A test road subjected to intensified calcium chloride attack during two winters confirmed the finding that portland cement containing one-twentieth of one per cent of this material does not scale. Fineness of the cement had little effect, and amount of mixing water, although important, was not the major factor.*

INCREASING USE OF SALT—either common salt or calcium chloride—to remove ice from concrete roads on grades, curves and intersections has led to many complaints of scaling of the concrete surface. Accordingly three years ago a study was begun in the laboratory of the Universal Atlas Cement Co. to find means of preventing this scaling. Certain discoveries made in this work led to the construction of a test road at the company's Hudson (N.Y.) plant, where a number of different cements were put under intensified full-scale test of many cycles of freezing and chloride thawing. This road test has established definitely that scaling can be prevented by introducing minute amounts of a wood rosin product—Vinsol Resin—into the cement, and that other factors of the concrete have at best minor influence.

Occurrence of scaling

Ice on roads is a serious traffic hazard, and its prompt removal is important. Use of salt for this purpose subjects the pavement not only to the action of the salt but also to many more repetitions of freezing and thawing in winter than it would ordinarily have to withstand. The surface of concrete pavement so treated frequently comes off in scales ⅛ to ¼ in. in thickness, leaving the coarse aggregate exposed and the pavement surface rough. Such scaling may be seen in the view at the left in Fig. 2, which shows two test sections that have scaled, while the section at the right has not scaled; all three sections had had 60 applications of ice-salt treatment during two winters.

Sometimes concrete pavements located in regions of frequent freezing and thawing develop scaling even though no salt is applied. Two kinds of such scaling generally recognized are *manipulation scale* and *progressive scale*.

Manipulation scale is caused by overworking the pavement surface in finishing, which brings the fines and excess water to the surface and produces a weak mortar coating. After this weak coating has scaled off the fresh surface is sound and no further deterioration occurs, the pavement thereafter giving satisfactory performance. Outside of its unsightly appearance, manipulation scale is not considered particularly serious.

Progressive scale is a continuing deterioration after the top mortar has come off, the action proceeding deeper into the slab until resurfac-

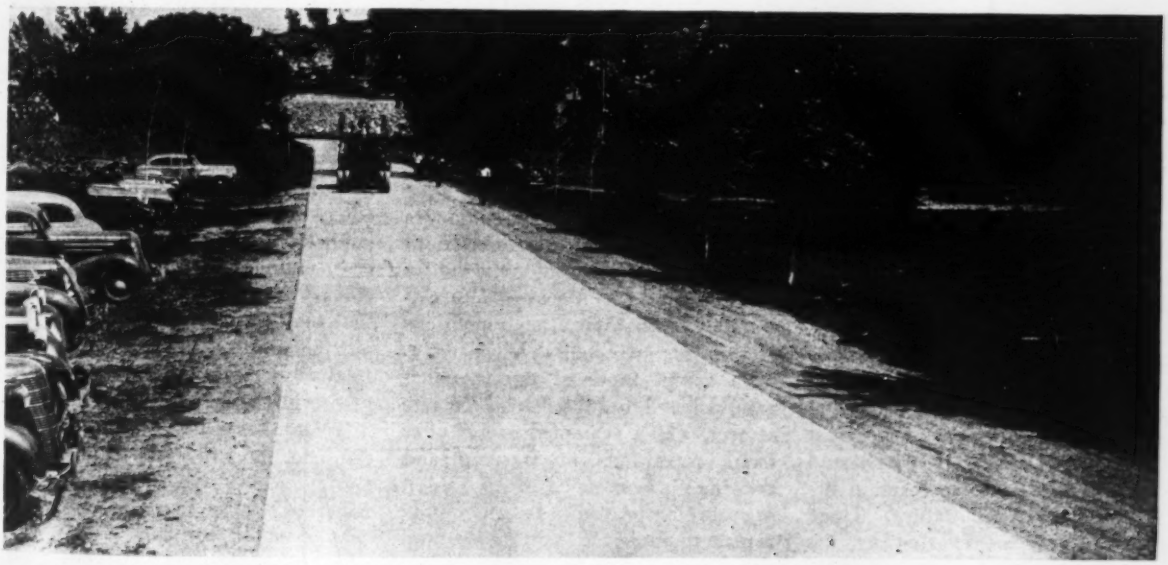


Fig. 1. Test road at Hudson, N. Y. Successive 20-ft. lengths were made of different types of concrete, and one corner of each length was diked in winter and subjected to repeated freezing followed by a heavy application of calcium chloride to thaw the ice. Different cements, two sands, and medium and wet consistency, were used.

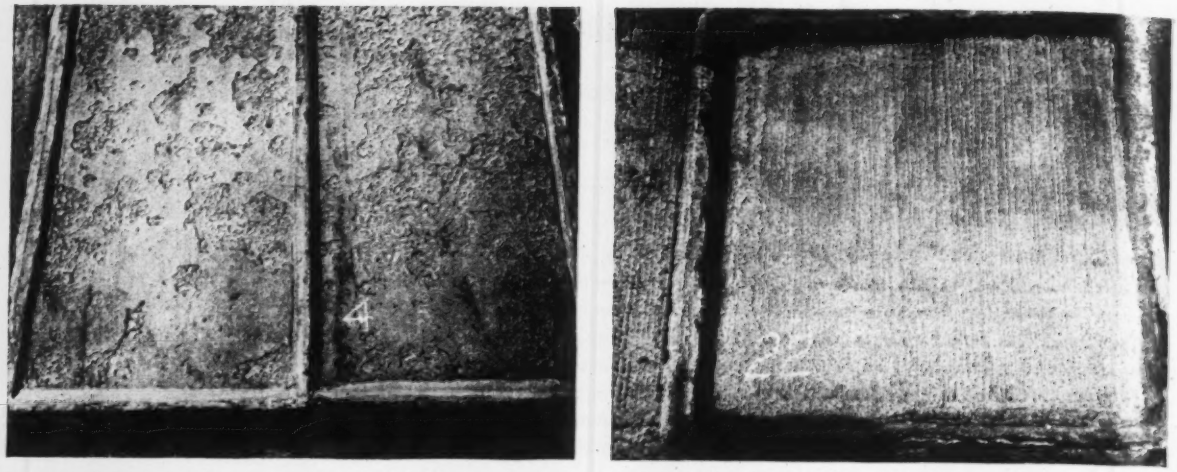


Fig. 2. Chloride-scaled pavement and scale-resistant pavement. Different sections of the Hudson test road are shown. The raised rims are dikes built around the test areas to hold water for freezing and to confine the salt solution formed by application of calcium chloride to melt the ice. Each of the three areas shown had gone through 60 cycles of freezing and thawing during the two winters 1938–1940.

ing sometimes becomes necessary. The primary cause of progressive scale is inferior sand, whose particles break down under alternate freezing and thawing, which in turn breaks down the mortar.

As may be inferred from these brief descriptions, salts used for ice removal not only cause scaling where it would not otherwise occur but also aggravate manipulation and progressive scaling.

Natural cement blend found resistant

To investigate the role of cement in the salt-scale problem, the New York State division of highways in 1935-36 built 13 experimental sections of concrete highway, using portland cements of various computed compound compositions as well as blends of these various cements with two natural cements. Cores drilled from these sections and subjected to freezing and thawing in a solution of calcium chloride exhibited, among other things, a decided increase in resistance wherever one of the two natural cements was blended with any of the portland cements; the other natural cement, however, was generally ineffective. On the experimental road, resistance to scaling under calcium chloride ice removal treatment was found to correspond to the resistance of the cores as determined in the laboratory. These experiments were reported by Ira Paul, of the state highway laboratory, in a paper "Chloride-Salts-Resistant Concrete in Pavements" (*Proceedings* of the Association of Highway Officials of the North Atlantic States, February, 1938).

The particular natural cement found effective in these blends performed similarly in later investigations, discussed below. These later studies led to the conclusion that the cause of the improved resistance of this cement to freezing and thawing action is the presence of a small amount of fat or grease.

During the winter of 1937-38 the research laboratory of the Universal Atlas Cement Co. began a study of the scaling problem. Small concrete slabs were made of various portland cements, the portland-natural blend found effective in the New York State investigation, and special laboratory cements. One of the latter contained a small amount of fish-oil stearate made from cod oil, which was being investigated as a plasticizer.

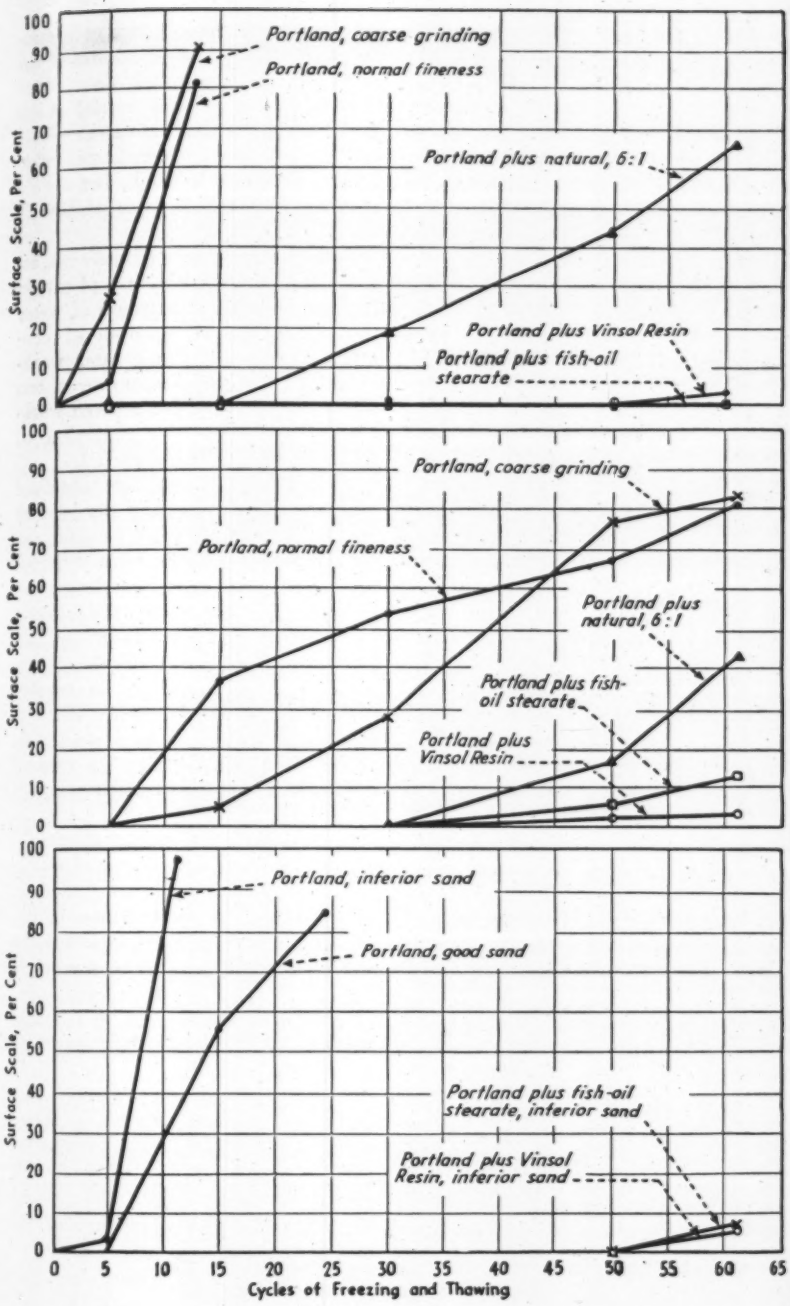
Fish oil stearate shows promise

These slabs were stored outdoors and their top surfaces subjected to natural freezing of water retained by dikes, followed by thawing with calcium chloride. After a few repetitions of this treatment, all slabs began to scale except those of the portland-natural blend and the fish-oil stearate cement, which remained sound after many repetitions of freezing and thawing. Eventually the fish-oil stearate slab proved to be much more resistant than the portland-natural slab.

Since the freshly mixed concrete of the two slabs of greatest resistance contained more entrained air than the other slabs, it was assumed that entrained air had something to do with prevention of scaling. A search was made for other materials which would entrain air, and Vinsol Resin, a wood rosin product of uniform quality, was selected as the best all-round material. Subsequent tests confirmed the inference. They showed that slabs of portland cement containing small amounts of either Vinsol Resin, fish-oil stearate or cod oil do not scale after many repetitions of the ice-salt treatment; 2-in. cubes of these mortars, frozen and thawed in water instead of salt solution, showed the same remarkable resistance.

The behavior of the fish-oil stearate cement prompted the laboratory to examine the natural cement as well as the portland cements for grease-like materials. It was found that the natural cement contained about 0.07 percent of fat or grease (fatty-acid materials), extracted by means of ether. The portland cements so examined contained about 0.008 percent, undoubtedly oil from mill machinery bearings. This test suggested that the increase in resistance of the portland-natural blend was due to the relatively large amount of fat or grease in the natural cement.

To test these laboratory results in the field, the Universal Atlas Cement Co. in 1938 built an experimental concrete road at its Hudson (N. Y.) plant, under standard New York state highway specifications. The work was done by an experienced contractor, using the usual highway equipment and good limestone aggre-



Figs. 3. Effect of cement on scaling of concrete surface, Hudson test road. After each freezing, the ice was thawed by applying 2 lb. flake calcium chloride per sq. yd. (Upper) Inferior sand, medium consistency. (Center) Good sand, medium consistency. (Lower) Inferior or good sand, wet consistency.

gate. The road, serving as the main entrance to the plant, is 540 ft. long and 18 ft. wide, with an 8-7-8-in. cross-section. It is divided into 20-ft. lengths separated by dummy joints, each length containing concrete of a given type. Duplicate lengths, not contiguous, were constructed for each type of cement and sand used. A general view of a portion of the road is shown in Fig. 1.

Two kinds of sand were used. The first half of the road was constructed with a sand having a good service record and showing a loss of about 4 per cent in the sodium sulphate test for durability, while the second half was built with a sand having a poor service record and showing a loss of 20 per cent in the sodium sulphate test. In addition, several slabs were laid of very wet consistency, with cement and sand as the variables.

The following cements were used in the construction of the pavement, the portland cement being from a single mill, and the natural cement the brand found effective in the New York State investigations referred to previously:

Standard portland
Coarse-ground portland
Portland plus natural, mixed 6:1 by volume on the job
Portland plus 0.05 per cent fish-oil stearate ground in at the cement mill
Portland plus 0.05 per cent Vinsol Resin ground in at the cement mill

The portland cement contained about 0.008 per cent of a material (probably oil) extracted by ether, and the natural cement about 0.07 per cent of a heavy grease of the nature of animal fat.

Tests on road surface—During the winter of 1938-39, tests using calcium chloride for ice removal were made on a 6-ft.-square section of each slab of the road. Dikes were built around the sections and water added. When freezing occurred, the ice was melted with 2 lb. of flake calcium chloride per square yard of surface. Thirty cycles of freezing and thawing were obtained in this way during that winter and thirty-one cycles during the winter of 1939-40. The percentages of scale occurring on the surface of the various slabs are plotted in Fig. 3.

The slabs constructed of standard cement (two finenesses) and inferior sand were from 80 to 98 per cent scaled after 10 to 15 cycles of the treatment. With the good sand, both finenesses gave a better performance (two top charts, Fig. 3). The portland-natural blend gave a better performance than the standard cements, especially during the first winter, when no scaling occurred with the good sand, against 15 to 23 per cent scaling with the inferior sand; however, scaling of the blend progressed rapidly during the second winter, reaching rather high percentages especially with the inferior sand.

In the portland containing fish-oil stearate or Vinsol Resin, not a trace of scaling developed during the first winter with either inferior or good sand, and only a relatively small amount the second winter. It happens

that this small amount of scaling during the second winter was somewhat greater with the good sand than with the inferior sand, but as the corresponding test on cores showed practically equal resistance with the two sands, this difference is probably nothing more than one of the usual variations encountered in testing concrete.

Tests on cores—In February, 1939, the New York State division of highways cored the pavement and subjected the cores to freezing and thawing in a 10 per cent calcium-chloride solution. It also furnished duplicate cores to the Portland Cement Association laboratory for similar tests. The results of both laboratories on the cores agreed in general with the scaling results obtained on the road surface, as to the resistance of the various concretes.

The performance of the slabs containing either Vinsol Resin or fish-oil stearate is remarkable, since the use of 2 lb. of raw calcium chloride per square yard is probably much more severe than ordinary practice.

Further studies in progress

While the work with Vinsol Resin and similar substances was going on in the laboratory of the Universal Atlas Cement Co., the New York State division of highways found that small amounts of beef tallow ground into cement made the resulting concrete very resistive to chloride-salt scaling and to freezing-and-thawing action. In July, 1938, the state tested this material in a section of concrete highway on Long Island, the results showing marked resistance. As a result of this experimental section and the Universal-Atlas experimental road, at least ten experimental sections of concrete highway and streets were built last year in several states to test the value of Vinsol Resin or tallow, or both, and at least two more experimental sections are under contract this year. Several of these projects are on an extensive scale.

Characteristics of the concrete

Both Vinsol Resin and tallow, as well as other materials of this nature, reduce the unit weight of concrete by introducing air, uniformly distributed throughout the mass in microscopic voids. These tiny air globules increase workability and prevent segregation (of the water, cement, sand and coarse aggregate) both of which are very desirable properties in concrete. They also reduce the strength of the concrete, just as an increase in mixing water decreases strength. The improvement in workability permits some reduction in water-cement ratio, which tends to offset the loss in strength where specifications permit reduction of water ratio.

The volume of air voids increases with the quantity of resin or tallow in the cement, with the slump of the concrete, and with the leanness of the mix. The maximum resistance to scaling is produced by a definite amount of admixture (about 0.03 to 0.05 per cent for Vinsol Resin), varying somewhat with the cement. It is fortunate that the maximum scaling resistance is produced by these relatively small amounts, as the reduction in strength up to this point is not serious. It is important to use only the proper amount, to avoid unnecessary reduction in strength without gain in scale resistance. Further, larger amounts make the concrete sticky and difficult to finish with modern finishing machines.

The reduction in compressive strength and unit weight of concrete which accompanies the increase in resistance to freezing and thawing may appear disturbing at first thought, for it has been generally accepted that the denser and stronger the concrete the greater its durability. For many years the compressive strength of concrete has been moved steadily upward and far beyond that needed to carry its load, in the belief that durability increases with strength. The belief is undoubtedly true up to the point where modern requirements for making good concrete have been satisfied, but beyond this point the theory that strength is an index of durability may not be true, and further investigation appears to be warranted.

Conclusions

1. Resistance to salt-scaling of concrete was attained by using cement containing certain very small amounts of fatty or resinous materials. Fineness of cement had little effect. Water-ratio of the concrete also was not the major factor. Laboratory and field tests agreed closely in demonstrating these facts.

2. The scale-resisting effect of fatty or resinous material ground in with the cement is due to its action in entraining air during concrete mixing. The entrained air practically eliminates segregation and bleeding of the concrete. This prevents the formation of a layer of weak mortar at the surface. The amount of entrained air and the reduction of weight per cubic foot of concrete is small, but a substantial increase in workability is obtained.

3. Some reduction of strength accompanies the entrainment of air, in the same degree as increase of water voids reduces the strength of concrete. Because of the greater workability of the concrete, however, less water may be used for a given workability, and thus the reduction of strength may be counteracted.

4. Optimum results are obtained with a definite amount of the fatty or resinous material (0.03 to 0.05 per cent for Vinsol Resin with different cements). Larger amounts lessen the beneficial effect and cause the concrete to be sticky and hard to finish with pavement finishing machines.

5. The deleterious effect of inferior sand (sand of low resistance to freezing and thawing or to sodium sulphate test) is reduced when cement containing fatty or resinous material is used.

6. The scale resistance of certain natural cements heretofore observed is due to the fat or grease found in these natural cements. Although the quantity found in the natural cement was relatively large, its total amount in a 1:6 blend of natural and portland cement was less than half enough to produce maximum scale resistance.

7. Portland cement when ground with the optimum amount of scale-preventing additions gave results superior to those obtained with the natural-portland blend, which contained less than the optimum amount of such materials.

8. A wood rosin product that had been under study as a grinding aid, Vinsol Resin, was found to be the best all-around scale-preventing material.

9. Because of this anti-segregating effect, confirmed by the scale resistance shown by concrete of wet consistency, it is probable that the scale-resisting addition will also be of value in preventing manipulation scale. Further, the improved resistance of cores made with cement containing the scale-preventing addition, particularly when inferior sand was used, suggests possible merit also in preventing progressive scale.

Revamping a 50-Year-Old Sewer System

W. D. P. Warren
Warren & Van Praag, Inc.
Consulting Engineers, Decatur, Ill.

***Contents in Brief**—Overtaxed sewers in Decatur, Ill., called for modernization of a system installed more than a half-century ago. This article tells of the construction problems which arose and how they were solved. Of special interest is the method used in relining an old sewer with shotcrete.*

SEWERS FOR DECATUR, ILL., entirely adequate when built in 1884, had become overtaxed and the need for remedial measures was imperative. The usefulness of the existing system was carefully considered in designing the new sanitary and stormwater facilities, and the new construction therefore became a problem of relieving the old sewers at strategic points.

Size range from 15 to 108 in.

The entire project, divided into twelve sections, consisted of the construction of 5 miles of new sewers and the relining of 2.8 miles of 20-year-old sewer pipe. New sewers ranged in size from 15 in. (vitrified pipe) and 24 in. (concrete) to a circular concrete sewer with an inside diameter of 108 in. and a concrete arch 10 ft. $10\frac{1}{2}$ in. by 13 ft. $7\frac{1}{4}$ in. in section.

On two contracts involving the use of 72-in., 85-in., and 96-in. concrete pipe, work was done in the tunnel without pressure, while the 108-in. circular concrete sewer was built under 5-lb. air pressure.

Arch sewer construction

Construction of the 108-in. circular concrete arch sewer was the largest single job. It was built from the center toward the two ends from a single shaft. Though the grade of the sewer did not require the use of air, pressure of 5 lb. was deemed advisable to guard against excessive seepage. Most of the material encountered was easily removed with air spades and was stiff enough so that no roof shoring was required until a 10-ft. panel had been excavated.

Outer forms, built in 10-ft. sections, consisted of 4-in. timbers in favorable ground, and steel ribs in bad ground. Steel arch rings were placed every 5 ft. to support the timbers. Steel inner forms were built in 55-ft. panels, and were held in place by wedges and hydraulic spreader jacks.

Concrete was mixed at a central plant, and delivered to the point of placement in agitator trucks. From these it was handled through 8-in. shafts spaced about 100 ft. apart. Through these shafts, averaging 40 ft. in depth, it was chuted to mine dump cars, thence hauled to the heading. Concrete for the arch was pumped to place after each 55-ft. section had been bulkheaded. The ceiling area over each joint was then pressure-grouted to fill any pockets not reached by the concrete.

On the construction of the 96-in. circular sewer, considerable difficulty was encountered. Air was used for a time but later was abandoned in favor of wellpoints. This job was through sand, with the sewer grade from 10 to 20 ft. below ground level. Steel outer forms were used throughout. No great trouble was met until the work was half completed, when the digging suddenly holed into an underground lake which flooded the completed portion of the tunnel and exceeded 1 mgd. Wellpoint equipment was rented to keep the work in the dry, and material was hand-excavated. Concrete was pumped to each bulkheaded 50-ft. section.

Fig. 1. Inside form and moving rig on one of the reinforced concrete arch sewers.

Relining old pipe

Another feature of construction concerned the relining of 13,800 ft. of 20-year-old concrete pipe, including 7,500 ft. of 60-in., 2,600 ft. of 54-in., and 3,700 ft. of 48-in. pipe. The pipe was repaired by shotcreting the walls, the minimum thickness being 2 in. The walls of the old sewer had an average thickness of 4 to 6 in. (Fig. 3).

All loose material was removed with hand picks, and the entire surface was then sandblasted. Before concreting began, the surface was cleaned first with water and then with an air blast. Special care was exercised in cleaning exposed steel. Reinforcing consisted of road mesh fabric constructed of No. 10-gage

Fig. 2. Precast concrete sewer line which joins the arch section.

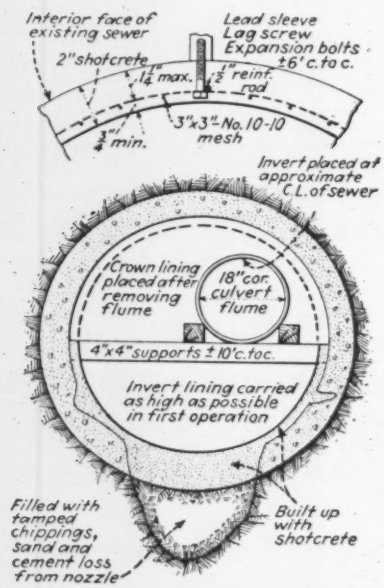

Interior face of existing sewer
Lead sleeve
Lag screw
Expansion bolts ±6' c. to c.
2" shotcrete
1" max.
1" reinf. rod
3"x3"-No. 10-10 mesh
¾" min.
Invert placed at approximate C.L. of sewer
Crown lining placed after removing flume
18" cor. culvert flume
4"x4" supports ±10' c. to c.
Invert lining carried as high as possible in first operation
Filled with tamped chippings, sand and cement loss from nozzle
Built up with shotcrete

Fig. 3. How the old sewer was repaired by using a 2-in. thickness of shotcrete.

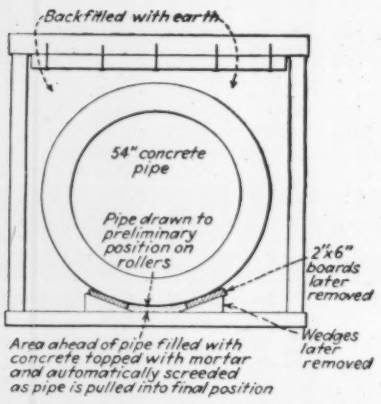

Backfilled with earth
54" concrete pipe
Pipe drawn to preliminary position on rollers
2"x6" boards later removed
Wedges later removed
Area ahead of pipe filled with concrete topped with mortar and automatically screeded as pipe is pulled into final position

Fig. 4. Method of providing proper support for 54-in. concrete pipe placed in the tunnel.

wires spaced 3 in. on centers both ways. Mesh was tied to ½-in. deformed reinforcing rods placed parallel with the axis of the sewer and spaced not more than 30 in. apart. The rods were supported by ½-in. expansion lag bolts set into the existing sewer barrel on 6-ft. centers.

The lining consisted of equal quantities of No. 1 and No. 2 torpedo sand mixed with portland cement in ratio of 1:3 and 1:3½. Production averaged about 1,000 sq.ft. per day of two 8-hr. shifts, and total cost ran slightly over 30c. per square foot.

Sewage was flumed across the areas being relined, flume sections averaging about 200 ft. in length.

Laying pipe in tunnel

Laying the 54-in. concrete pipe in the tunnel presented an interesting construction problem. Shafts were sunk every 80 to 100 ft., and the pipe was lowered through these with a ratchet crane. Excavated material was also handled through these shafts. When a section between headings had been timbered, the pipe was drawn to within a few feet of final position on rollers.

When a section was ready for sliding into final position, two 2x6-in. wooden skids were nailed to the bottom timbers on either side of the pipe centerline. These boards were wedged to the approximate diameter of the pipe, and the space between them was filled with concrete topped with cement mortar. As the pipe was drawn into final position it automatically screeded its own bed. Wedges and skids were later removed.

Concrete tests

To be assured that specified strengths were being uniformly secured the city engaged Robert W. Hunt Co., Chicago, to test all concrete. Both 2-in. cubes and 6x12-in. cylinders were cast as test specimens. The cube specimens were obtained from both side wall and floor, as the actual shotcreting proceeded. Seven cylinders showed an average compressive strength as follows: 3 days, 2,485 lb.; 7 days, 3,193 lb.; 28 days, 3,149 lb. Strengths of cube specimens averaged 3,188 lb., 5,250 lb., and 6,313 lb. at 3, 7, and 28 days, respectively. Higher strengths in the cubes were probably due to the fact that rebound from the gun did not get into the cubes, whereas it did into the cylinders.

Work on the relief sewer was participated in by the city, the Decatur Sanitary District, PWA and WPA, the total cost, including municipal participation amounting to $2,000,000, about equally divided between the two relief agencies. Additional projects costing $500,000 are planned for 1940.

Warren & Van Praag, Inc., were the consulting, supervising and inspecting engineers. Beecher Hughey is commissioner of streets and public improvements, and Carl Fox is city engineer. Contractors on the work included File & Collins-Birt Bros. Construction Co.; J. M. Driscoll & Co.; and Square Const. Co. of Cleveland.

Aid for Small Sewage Works in South Dakota

Although the sewage from about 69 per cent of the urban population of South Dakota is being disposed of in a sanitary and satisfactory manner (*ENR*, April 11, 1940, p. 500), there still remains much to be desired in the way of stream pollution or nuisance abatement. One reason for this, according to a statement by the State Board of Health in its bulletin, *The Clarifier*, is that many of the treatment plants are not operated as efficiently as they should be, since the average municipality having such treatment is too small to support a full-time operator. This means that the operation is just another duty assigned to "the water superintendent, city constable or night watchman." The mere existence of sewage treatment facilities does not insure adequate treatment. Intelligent operation is necessary, and it is false economy for a city to spend money for a treatment plant and then neglect its operation. "If the cost of construction is warranted, so is the cost of operation," says the report.

To remedy this difficulty, the engineering division of the Board of Health has inaugurated a program under which more actual assistance in the field will be available to the municipalities. The services of one man from the engineering division will be devoted almost entirely to this work, the service consisting of personal instruction on operating problems and technique, together with the necessary tests to determine the quantity of sewage, its strength and the extent of treatment.

Notes on the Waterworks Meeting

Technical sessions at the annual meeting of the New England Water Works Association in New York City on Sept. 24-27 included a number of papers of broad interest and usefulness. Of particular appeal at this time were the papers dealing with sabotage and water service. Extracts from these and other discussions are grouped in the following to give the readers of Engineering News-Record *a concise report of the meeting.*

WATER AND WAR

A HEAVY RESPONSIBILITY rests upon the water supply official of a community in wartime. Without neglecting any of his customary important duties, he must give his close attention to the following:

He must be on the alert. The operation of many water systems will follow the even tenor of their way through a war emergency, but the responsible official must not bank on this. Risk of damage from sabotage may be ever present, and an interruption of supply might have tragic results in paralyzing industrial production.

He must give special study to the points in the system vulnerable to damage either by sabotage, by shell fire, by bombs, or by any phase of military operation, and should have a procedure studiously planned for making good such damage with the least possible delay. He must have his organization instructed, and if possible, drilled in this procedure, and should carry in stock any materials, equipment or parts quickly obtainable and vital to the quick repair of the damage.

He must make every effort to anticipate the needs for water for industrial purposes arising out of suddenly developed war industries, and must do everything possible to assure that the required supply be available when needed, quickly enough to prevent shortages.

He must carry through an inquiry designed to insure prompt and definite knowledge as to where vital material or parts may be obtained, and also where experienced repair services may be obtained, and how quickly, in the event of an emergency need.

The editorial staff of *Engineering News-Record* has for some time past been discussing this matter with waterworks engineers and superintendents. An article in that journal, in the issue of July 18, 1940, p. 86, enlarges in considerable detail upon the foregoing, and can be read with advantage. (*Editor's Note: Reprint of the article may be had by addressing this journal.*)

The New England Water Works Association has a committee on waterworks emergencies, which has recently rendered its first report. While the emergency of war was not foremost when this report was compiled, there is nevertheless much therein that is pertinent to the safeguarding of supplies exposed to the menace of war damage.—F. F. LONGLEY, *vice-president Lock Joint Pipe Co., Ampere, N. J.*

Discussion: Col. Longley as a graduate of the U. S. Military Academy later resigned from the Army and for years associated with one of the most distinguished consulting water engineering firms of the country was especially well-qualified to undertake the responsibility of chief of the water service in the American Expeditionary Forces during the last World War. His skill and tact in adjusting the very delicate relations between the sanitary engineer and the medical man during this period constituted an outstanding contribution.—ARTHUR H. PRATT, *consulting engineer, Newark, N. J.*

For some years the engineers of the Sanitary Corps have been engaged in developing methods for the detection, neutralization and removal of warfare gases from water. If water supply should become contaminated with certain of the so-called poison gases, as mustard, a problem of a serious and important nature would be created. In cooperation with the Chemical Warfare Service, much experimental work has been done, including the development of tests and methods of removal for various types of gases. The procedures developed for treatment are essentially in line with standard water purification practices and in case of threat or emergency would be made available to all water supply plants. Except in unusual cases, gas contamination can be neutralized or removed so as to eliminate any danger from the use of the water; and in many or most cases even the accompanying taste and odor can be removed.—W. A. HARDENBERGH, *vice-president, Public Works Magazine, New York City.*

Active investigation of the effect of bombing on dams and gate control houses should be undertaken in this country in order to gain information concerning the effects of such damage and to examine all possible precautionary measures. — THOMAS H. WIGGIN, *consulting engineer, New York City.*

An unusual opportunity exists for our state sanitary engineers to coordinate and emphasize the adoption of safeguards. In fact, they represent the logical agencies to assume aggressive leadership in this vital campaign. Many state sanitary engineers have already perfected organization plans and technique for dealing with emergencies such as floods and earthquakes, and thus they are ideally equipped and ready to cope with sabotage emergency. Furthermore, the state sanitary engineers are familiar with the personnel, the plant, and the problems of the water purveyors in their respective areas. In other words, each state may be considered as already having an established clearing house for the collection and dissemination of information on water supply sabotage protection. When and if it should become necessary for the federal government to participate in municipal water supply sabotage precautions, it certainly will be more desirable to work with a group of 48 established and specially qualified representatives than to set up a new and separate agency attempting to

represent the 12,800 waterworks in this country.—E. J. CLEARY, *associate editor, Engineering News-Record, New York City.*

In Canada protective measures at municipal water plants were initiated last year when war was declared, but plans for safeguarding these and other utilities were made two years ago. The principal precautionary measures included the employment of guards, the installation of barbed wire barricades and floodlighting at vital spots in the system, and the exclusion of all visitors to waterworks properties. At Toronto the use of guards during a six-month period cost $180,000 and because of the expense the guards were dismissed. Meantime the Secret Service had tabbed all suspicious people, and certain individuals were put in concentration camps. Safeguards adopted by British waterworks include installation of emergency equipment, particularly extra disinfection devices, and a system of interconnections with adjacent water supplies.—NORMAN J. HOWARD, *Director of Water Purification, Toronto, Ont., and president American Water Works Association.*

SUPERVISION OF DAMS

The public is entitled to supervision of structures that impound water, the failure of which would cause loss of life and property damage. Connecticut early recognized the importance of supervising dam construction, and has had statutes for at least 70 years providing for inspection of dams.

Following the floods of September 1938, when a number of old dams failed with resultant large property damage, it was the consensus of opinion that broader powers than hitherto existed should be created for state supervision of dams. In 1939 a new act was passed creating a six-man board for this purpose.

This new act gives the board authority and orders it to "investigate and inspect or cause to be inspected all dams or other structures which, in its judgment would, by breaking away, cause loss of life or property damage." Furthermore, periodic inspection of all such structures is required. The act also provides that any person, firm or cooperation which would suffer loss of life or property by the breaking away of any such structure may petition the board in writing for an inspection.

The board is authorized to issue permits for dam construction after an examination of plans and an inspection of a proposed site. On completion of the work a certificate of approval is issued, but subject to such terms and conditions, if any, as the board may deem necessary for the protection of life and property. Small dams for recreational and other purposes or, in general, any dams with less than one-half square mile of watershed or less than 5 ft. in height do not come under the provisions of the statutes.

So far the board has completed an inventory of all dams in Connecticut, and is now making a study of the characteristics of sample watersheds and the application of the pertinent data obtained to the watersheds of similar areas and characteristics.—CLARENCE M. BLAIR, *consulting engineer, New Haven, and member of the Connecticut board of supervision of dams and reservoirs.*

NEW PIPE LINING

Tuberculation in pipes lined by the ordinary tar dip process is due to pin holes or defects in the lining, and attempts to eliminate it have resulted in the development of bituminous and cement linings. Despite their success in avoiding contact between water and the cast iron, these coatings have two major objections—they significantly increase the cost of the completed pipe and their thickness reduces its carrying capacity.

The research laboratories of Arthur D. Little, Inc., of Cambridge, Mass., worked on the problem of producing a lining of adequate thickness and evenness to preclude the presence of pin holes but which would not be so thick as to reduce the effective diameter of the pipe. It was further stipulated that this coating must be so firmly bonded to the pipe that it would not flow or peel off when subjected to hot weather, and yet be tough enough not to chip or flake off when roughly handled during cold weather.

It was found possible to meet all these requirements by applying to the interior of the pipe a composition of coal tar and mineral fillers, coking this at relatively high temperature (550 deg. F.) to obtain a porous lining of carbon and mineral filler tenaciously attached to the pipe, and then saturating this porous coat with tar during an automatically controlled tar dipping step. The function of the undercoat is to provide a tough, hard, infusible, insoluble and firmly bonded framework which will absorb and hold the tar which is later applied. During the high temperature period preliminary to coking, the undercoat composition flows easily enough to smooth out any irregularities in the pipe as cast and, after coking, presents a smooth, satinlike surface.

The coke-tar lining, commercially available under the trade mark "Hi-Co," can be applied in the cast iron pipe foundries which are now equipped for tar dipping. The complete thickness of the undercoat is 1½ to 3 thousandths of an inch, while the thickness of the final two coats is 4 to 5 thousandths of an inch.—H. J. BILLINGS, *research director, Arthur D. Little, Inc., Cambridge, Mass.*

SANITATION OF CONSTRUCTION AREAS

To safeguard the health of construction workers on New York's new Delaware Aqueduct, and to prevent the pollution of water in existing reservoirs, the adoption of a special sanitation program was called for.

Construction specifications prepared by the New York Board of Water Supply require that all water which may be used for drinking, except that from approved public supplies, must be chlorinated. Contractors have resorted to the use of public water supplies, existing reservoirs, and deep wells for their supplies. In most cases, sterilization is accomplished with sodium hypochlorite solutions. Following an investigation of the character of drinking water in pails and other open containers, the contractors were required to provide closed containers to eliminate chance contamination.

For the use of small groups of workmen located at a distance from centers of activity, it is required that chemical toilets with watertight removable receptacles be provided. At twenty of the construction sites sewage disposal plants have been built, and at the other five sites connections have been made with existing public sanitary sewers. At all but two sites the treatment plants consist of septic tanks, dosing tanks, intermittent sand filters and effluent chlorinators.

Sewage from the construction areas is quite weak because of the large amount of washwater from the shower

baths. The flow shows variations from 8 to 54 with a general average of 25 gal. per man per day.

As a rule, drainage water from construction operations is passed through settling basins to remove suspended matter and the effluent is treated with chlorine. Where tunnel muck is dumped in shallow areas along the shores of existing reservoirs, facilities have been provided to spray the muck with a chlorine solution. Some of the spraying is done as the muck is dumped into the truck from storage hoppers, and the balance has been sprayed in the truck after loading. By experiment it has been found that about 4 gal. of a solution containing 1 per cent of available chlorine will properly treat a cubic yard of broken rock.—FRANK A. MARSTON, *partner of Metcalf & Eddy, Boston, Mass., and consulting engineer, Board of Water Supply, New York City.*

QUALITY DEPRECIATION IN DISTRIBUTION

At times when field indications are that water treatment is being carried out effectively, occasional distribution system samples will show up poorly by analysis, for reasons not apparent at first glance. A study of samples from three distribution systems in Connecticut, collected weekly over a period of a year, correlated with field observations of residual chlorine tests and other related data, has indicated that temporary interruption of chlorination or inadequacy of chlorine dosage may leave after-effects, so that poor distribution samples may be obtained for many days or weeks.

Some of the conclusions derived from this study were:

Ortho-tolidin control of chlorine dosage by periodic manual tests is unquestionably ineffective at times, especially for unfiltered surface waters, due to rapid changes in the chlorine demand.

Until more water laboratories adopt strict adherence to "Standard Methods" so as to build up more comparable analytical data and until better and more comprehensive analyses are made of distribution system sampling results, it is unwise to adopt more stringent bacteriological limits as part of the U. S. Treasury Department's standards. These limits after all are based more on the ability of treatment plants handling polluted water to produce conformity than on any disease or experience data on the large number of chlorinated surface water supplies derived from clean watersheds.

The experience of the Connecticut survey brings once again to mind that bacterial infection of a distribution system may occur in a relatively short number of hours or even minutes, due to a temporary lapse in treatment. This lapse may not be disclosed by examination of routine samples at the point of treatment. At the same time it should be borne in mind that even in the face of apparently adequate treatment, analyses of samples from distribution systems occasionally give puzzling laboratory results.

For small unfiltered surface supplies, even for large supplies of similar types, superchlorination followed by dechlorination may be the ultimate answer to unsatisfactory disinfection occasionally obtained.—WARREN J. SCOTT, *director, Bureau of Sanitary Engineering, Connecticut State Department of Health.*

WATER FINANCE POLICY

Municipal water plants should develop a sound financial policy through rates which will provide sufficient revenue to pay operating expenses, interest and amortization on outstanding debts, if any, and amounts sufficient to cover ordinary additions to the waterworks, as well as an amount to cover the average annual requirement for major additions. The obvious result of such a financial policy is to gradually retire all outstanding indebtedness and to build a well-distributed construction program from revenue.

It will be noted in the above itemization of funds to be secured from revenues, nothing is said about depreciation. It is the writer's belief that if the present generation of consumers pays interest on the outstanding debt (if any), provides for amortization requirements, and in addition pays for new construction out of earnings, it is certainly the responsibility of succeeding generations of consumers to provide for replacements of property from their current revenues. To charge present consumers for both amortization of debt and depreciation reserve for replacement of previously amortized property is an unwarranted duplication of charges.

Considered over a long term, the cost of financing from current revenues is only about 60 per cent as costly to the consumer as financing by bond issues. Costs are amortized as incurred without interest charges, and there are other advantages.—LOUIS R. HOWSON, *Alvord, Burdick & Howson, Chicago, Ill.*

WPA AND WATER SUPPLY

On June 30, 1940, the Work Projects Administration completed five years of operations under various programs authorized under the Emergency Relief Act of 1935 to 1939. In that period the expenditures of federal and sponsor funds on all construction projects assisted by the Work Projects Administration totaled $7,540,849,000. Of this sum approximately 6.8 per cent ($513,536,000) was expended on projects involving improvement of water supply and distribution and water conservation, in the proportions of 78.9 per cent federal funds and 21.1 per cent in sponsor funds.—J. T. HALLIHAN, *engineering division, Work Projects Administration, Washington, D. C.*

Discussion—It might be of interest to cite an example bearing on the engineering economics of WPA projects. Construction of a distribution system for a small waterworks was being carried on with a minimum of mechanical equipment; the labor furnished by the WPA was better than average. In the fall of 1939 it was decided to hire an excavator and attempt to finish the work before cold weather set in. The machine was rented at a cost of $5.50 an hour, including the operator, and the cost per cubic yard of excavation was 17¢.

The cost of the same kind of excavation by hand during the summer months had amounted to $2.10 per cubic yard; during the preceding winter the cost had been $5.08 per cubic yard. Comparing these prices with the unit cost of 17 cents for machine excavation, the savings ranged from $1.93 for summer conditions to $4.91 for winter conditions.

We are wasting national wealth, whether in terms of idle machinery or man-power, when men are used to do work that can be done much cheaper by machines. The point I am trying to make is that WPA is for unemployment relief and that its existence can be justified for no other reason.—SAMUEL M. ELLSWORTH, *consulting engineer, Boston.*

Foundation Exploration at Kentucky Dam

A. V. Lynn and Roger F. Rhoades

Field Engineer and Geologist, Tennessee Valley Authority

***Contents in Brief**—For more than four years prior to start of construction of Kentucky Dam last July, the Tennessee Valley Authority conducted an intensive exploration of the site. The large scope of the investigations, the completeness of the integration of engineering and geological observations, and the quantity of drilling, test pitting, sampling and other exploratory procedure characterized the preliminary investigations as unusual, if not unique, in their thoroughness.*

START OF CONSTRUCTION on Kentucky Dam last July was preceded by an extensive four-year program of investigation of the site involving core drilling, wash boring, sinking of test pits, sampling of soils by all known means and a thorough coordination of engineering and geological observations. The preliminary investigations were the most elaborate ever undertaken by the Tennessee Valley Authority, and as far as known, about the most thorough ever made for a large dam. Kentucky Dam, largest of all TVA projects, will be a combination concrete and earthfill structure 8,650 ft. long and will create a reservoir 73 ft. above present river level. It is located on the Tennessee River near Gilbertsville, Ky., 22 miles above its confluence with the Ohio at Paducah.

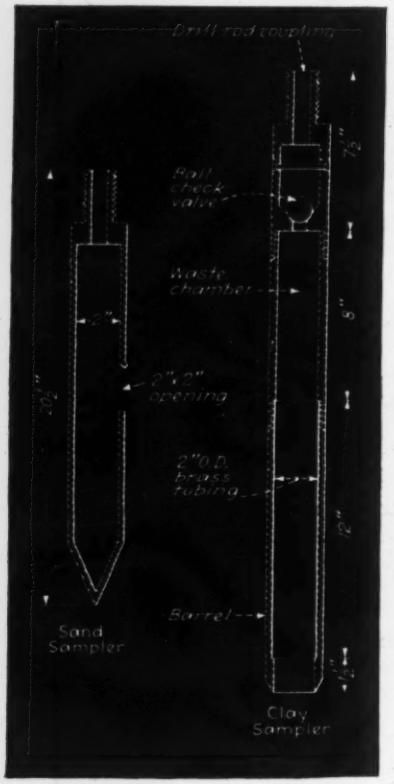


Fig. 1. Two types of tools which proved best for sampling overburden.

Geological setting

In ancient times the lower Tennessee River, along with the adjacent parts of the Ohio and Cumberland rivers, carved a broad and deep valley in the underlying bedrock. At the site of Kentucky Dam, the rock floor emerges to the surface at the eastern edge of the present river valley and ascends close to the surface on the western side; but in the central part of the valley it is buried by alluvium fill from 60 to 125 ft. below the present river and the adjoining flood plains.

The bedrock is a siliceous and cherty limestone, uniform throughout the site, and extends unchanged for several hundred feet in depth. The overburden is mainly heterogeneous alternations of sand and gravel with occasional lenses of clay, though the top 20 or 30 ft. of the flood plain is composed of impervious clays. In some places the overburden close to bedrock is bouldery residual accumulations of chert and clay, formed in place as the residual products of decomposition of the impure limestone.

These conditions dictated the type of field exploration considered necessary to determine the following:

1. Profile of the bedrock and its geologic structure.
2. Location, extent and pattern of solution channels.
3. Character of the overburden including permeability, strength, thickness and other physical characteristics.
4. Continuity of the upper impervious clay of the flood plains and the west abutment ridge.
5. Possible depth and driving conditions for steel sheetpiling.
6. Groundwater and hydraulic conditions existing at the site.

Program of exploration

Prior to any specific exploration, a regional geological reconnaissance was made, and geological studies continued throughout the period of the investigations. After the final location had been selected, intensive study of the site involved many procedures in addition to the drilling. Sixteen test pits were dug, five of which went to bedrock. In these pits, the bedrock was exposed for minute examination and for the drilling of 36-in. shot-drill holes and flat angle borings; also undisturbed sediments were obtained for laboratory testing. The authenticity of drill samples was checked, and numerous inflow and pumping tests were conducted in the field, as well as shear and loading tests. Water-table observations were carried on for several years in wells and borings. Outcrops in the immediate and general vicinity were stripped for observation. The tests were culminated by sinking of a 20-ft. test cell, 90 ft. deep inside of steel sheeting. This cell was completed by freezing the saturated ground, as reported in *ENR*, May 11, 1939, p. 74.

Over 100,000 ft. of holes

A total of 817 borings aggregating 100,631 ft. were drilled at the site. This large footage was, in part, the result of having to penetrate the excessively thick overburden prior to core-drilling and partly the outgrowth of a desire to eliminate all guesswork concerning the existing conditions. Of this drilling, 58,982 ft. was in overburden and 41,649 ft. was in rock, mainly with diamond drills.

The intervals between the original vertical holes were methodically reduced by intermediate spacing of the subsequent drilling, both vertically

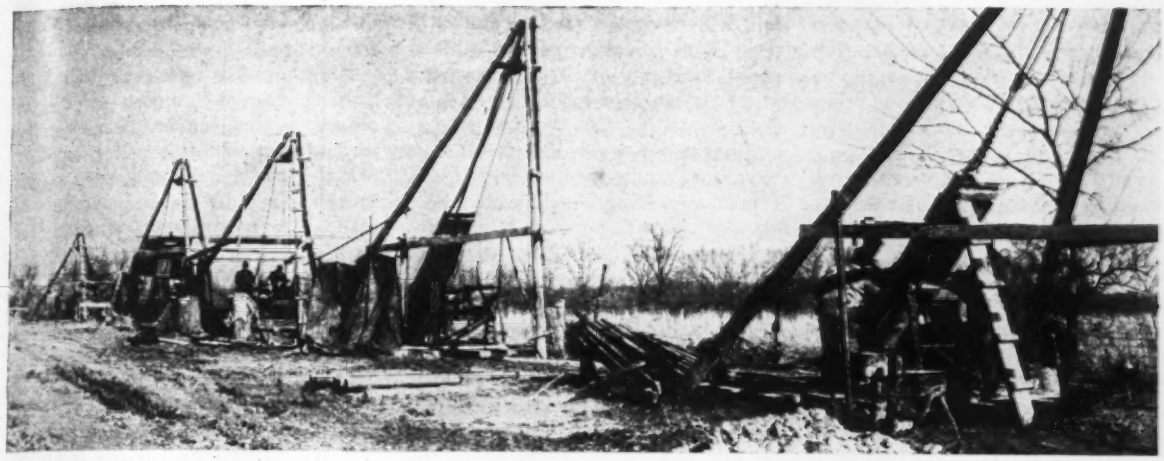


Fig. 2. Battery of rigs drilling overlapping angle test holes. Note casing guides used to start each hole.

and inclined, and as localities of rock solution or critical geological conditions became outlined, the later programs were concentrated in these areas.

Angle borings at 45 deg.

Inclined holes, drilled at an angle of 45 deg., approached complete coverage in that the top of one core overlapped the bottom of the adjoining one. In all, 156 of the exploratory borings, or 19 per cent, were drilled at an angle. As geological observations indicated that many of the solution channels in the bedrock were vertical in orientation, angle drilling was chosen to best reveal actual underground conditions. Moreover, by judicial combination of angle and vertical holes, it was possible to ascertain in many instances the exact nature of the cavities, whether vertical or horizontal.

Depth of drilling varied. At first the test holes ran 30 to 40 ft. deep though some were sunk to greater depths to determine how far solution had penetrated the lower parts of the bedrock. As solution was found to extend to considerable depths in some places, deep holes, yielding cores 100 ft. or more in length, were drilled in locations where sound foundations to such depths were required. The geologic structure of the site was tested by deeper borings penetrating the Chattanooga shale, a "key" horizon-marker which underlies the foundation rock by several hundred feet.

Although the overburden was extensively sampled as a routine adjunct of the drilling program, 767 auger borings, ranging from 10 to 65 ft. deep, were put down. These borings, together with numerous undisturbed samples, furnished specific data concerning the permeability, strength, continuity and thickness of the clays blanketing the flood plain and the west abutment, determined areas suitable for borrowpits and yielded samples for detailed laboratory testing.

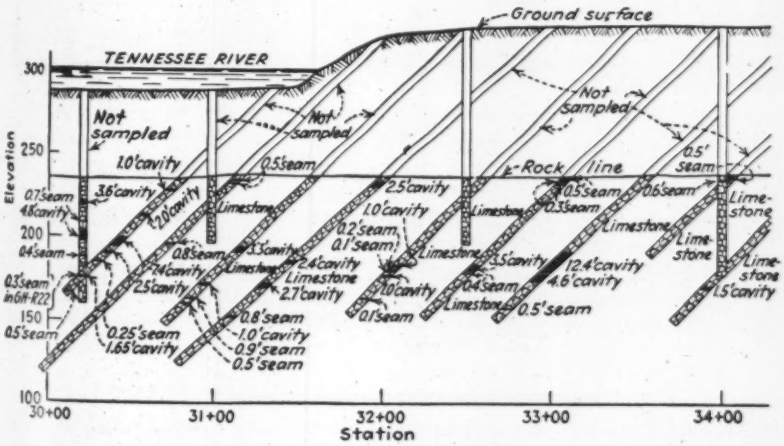


Fig. 3. Part of profile of holes bored on axis of dam, showing combination of angle and vertical drilling.

Permeability tests in the field

Because of the presence of the thick alluvial filling in the buried valley and of unconsolidated materials in the abutments and the adjoining reservoir rim, emphasis was placed on permeability tests conducted at borings and test pits. The tests were of two general types, depending on the amount of groundwater present. In saturated materials tests were conducted by pumping from a pit at a measured rate for a period long enough to insure stability of inflow into the pit; the drawdown and the cone of depression were noted and the velocities of inflow and coefficients of permeability were calculated. In localities where the sediments were not saturated with groundwater, such as reservoir rim above water table, water was pumped into test pits or borings at measured rates and the rates of leakage and the resulting water levels were noted.

It was felt that tests made on the materials in place furnished more realistic values of percolation and permeability than did laboratory tests on sampled sediments, which necessarily always involve elements of artificiality. The results of these field tests were usually more conservative than those of laboratory tests of undisturbed samples of similar materials in that higher values of permeability were indicated by the field test.

Separate tests were conducted on each class of sedimentary material encountered at the site, and materials of widespread distribution, as, for instance, the alluvium within the valley and the sands, gravels, and clays occurring on the reservoir rim, were subjected to repeated tests to verify the results and the range of values to be expected in various locations.

Overburden drilling

Most of the overburden drilling was done with core drills and small high-pressure piston pumps. The core drill served as a hoist for operating a 300-lb. hammer to drive or pull casing and to raise or lower chopping tools. The pumps circulated water through the borings to wash out loose material. Cable tool rings, commonly known as churn or well drills, were also used effectively for making a considerable number of borings in deep overburden.

Casing consisting of either 3½-in. extra heavy or 4-in. standard steel pipe, cut into 5 and 10-ft. lengths, was driven to bedrock in all borings. The pipe was pulled upon completion of each boring, except where the holes were to be used for foundation grouting or groundwater observation wells.

Extra heavy pipe could be redriven several times, but standard weight pipe frequently broke at the joints if used more than twice unless the ends were cut off and rethreaded.

It was found that casing could readily be driven through overburden on a 45-deg. angle to angular depths of 175 ft. or more. In fact, the angle borings averaged 114 ft. in overburden, and the rock cores obtained averaged 112 ft. in length. Equipment used for this work was the same as that for vertical holes, except that heavier drive hammers were required; two 300-lb. hammers bolted together gave good results. More water was necessary to wash material out of the angle holes, about 35 gpm being used for this purpose instead of 20 gpm for vertical borings. A casing guide, 1 ft. wide and 12 ft. long, was set up to the proper angle and the first piece of pipe carefully driven along the guide to start each hole (Fig. 2). The actual inclination of each boring was checked by a transit shot on a flashlight lowered into the boring or by a clinometer using hydrofluoric acid to etch a line on a glass tube. The borings were seldom straight from top to bottom, but their deviation rarely exceeded 3 deg. There was practically no difference in the rate of progress between angle borings and vertical borings of equal depth.

Several types of sampling tools were used in the overburden, but best results were obtained with those shown in Fig. 1. Samples of cohesive material were generally taken by driving the clay sampler to a depth that half filled the waste chamber. This would fill the brass tube for a laboratory sample and also provide material to be saved in glass jars for visual inspection. Laboratory samples remained in the brass tubes, sealed to prevent loss of moisture. The sand sampler was used in granular materials that could not be recovered with the other sampling tool. Obviously, samples taken with this device cannot be classified as undisturbed, but they are much more dependable than residue samples obtained by wash or bailing methods.

Numerous borings were drilled 30 to 35 ft. deep at low cost with an ordinary posthole auger. Holes can be made deeper with this tool if sand or gravel is not encountered, but the cost increases rapidly beyond a depth of 50 ft. Simple equipment consisted of a 3-in. auger, handle extensions of ¾-in. pipe cut into 4-ft. lengths, and two 12-in. pipe wrenches. Samples were collected at each pronounced change of material penetrated.

Rock drilling

All core drills were equipped with hydraulic feed swivel heads for rock drilling. Double-tube swivel-type core barrels were used, as they rarely broke the rock core except at bedding planes, whereas the single-tube core barrels quite frequently caused the

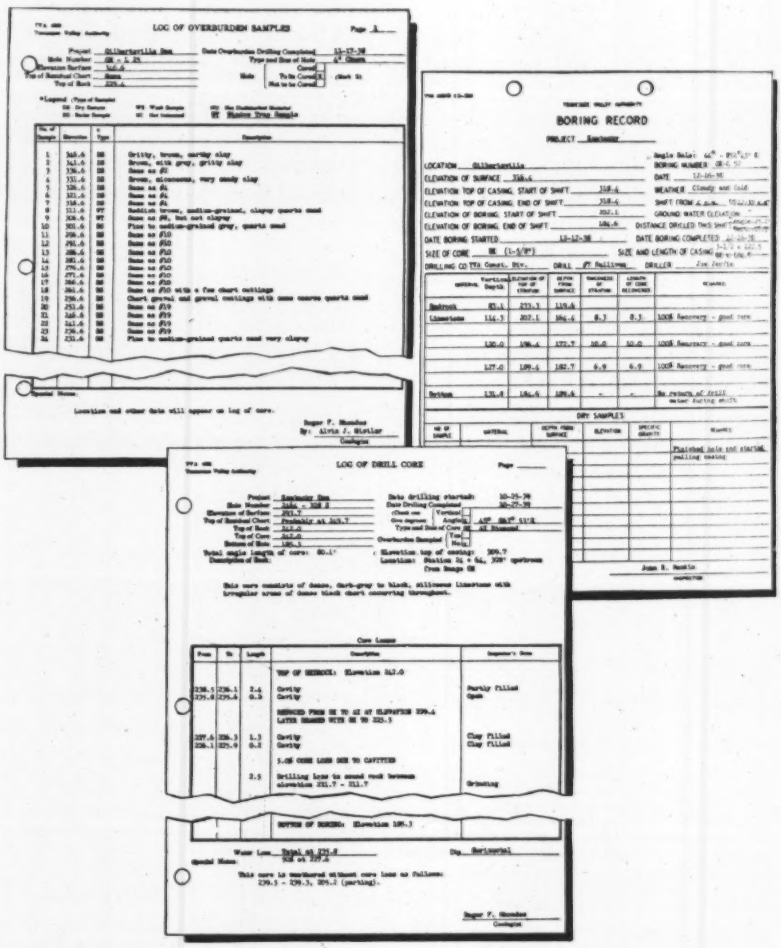


Fig. 4. Typical records of boring explorations. (Bottom) Geologist's log of core in cavernous rock (Right) Engineer's report of daily drilling progress. (Left) Geologist's log of overburden.

core to break into several short pieces.

Bortz bits set by hand were used during the early part of the drilling, but the bit cost was reduced more than 50 per cent by changing from hand set to precast bits. The latter type, which can now be purchased from several manufacturers of diamond drilling equipment, also increased the footage drilled per shift and eliminated the bit setting shop in the field. The salvage value of precast bits varied from 20 to 35 per cent of their original cost when their useful life was exhausted. Conditions under which these bits were used were severe because of the abundance of chert found throughout the rock.

Angle borings presented no particular rock drilling difficulties. Core barrels wore out faster in angle holes, but otherwise the cost of these borings was no greater than for vertical borings of equal depth.

For river drilling the barges were held in place by a 3-in. pipe spud anchor at each corner and two upstream anchors weighing 100 lb. each. River stage fluctuations up to 2 ft. caused no interruptions in drilling angle holes. The drilling equipment and procedure were the same as that used for land borings.

Correlation of field and office

By far the greater part of the drilling was done by the Authority, only the initial programs being contracted. The drilling, supervision, inspection and location were, therefore, combined under the direction of the engineer in charge to secure the maximum coordination and flexibility.

The drilling was supervised by inspectors charged with keeping records of only one or two drill operations except under unusual circumstances. Members of the geologic staff followed the progress of the drilling closely, visiting the drills at frequent intervals, discussing the conditions being encountered with the drillers and the inspectors, and finally preparing the log of the core. The inspectors filled out daily progress report forms from data transcribed from their field notebooks. Both the notebooks and the report forms became filed records of the detailed drilling operations.

Geological logs

The geological logs contained all data which might be expected to have a bearing on the interpretation of the bedrock conditions, special emphasis being placed on the elevations of any water loss during drilling, whether the cavities were open or clay filled, elevations of casing reductions, the apparent dip of the strata, if any, along with all pertinent dates, elevations, locations and rock descriptions.

The logs were the basis for profiles, contour maps of the bedrock surface, charts showing the distribution of the core loss due to cavities, construction of a peg model (described in *ENR*, Mar. 14, 1940, p. 54) and miscellaneous studies of the foundation conditions. Any unusual or specially significant conditions were the subjects of special geological and engineering reports and memoranda, as were all tests and investigations which departed from the routine.

In the case of holes in which the overburden was sampled, geologic examination of all samples was made and description of the samples was assembled to form a log of the overburden. Identical treatment was given to samples from the auger borings as a permanent record.

Direction

G. P. Jessup is project manager of the Kentucky Dam and J. B. Hays is construction engineer. The preliminary explorations were under the general supervision of E. A. Prokop, reservoir construction engineer. The writers, A. V. Lynn and R. F. Rhoades, were field engineer and geologist, respectively, throughout the period of the explorations. T. B. Parker is chief engineer of the Tennessee Valley Authority, and A. L. Pauls is chief construction engineer.

How Do You Carry a Garbage Can?

ALTHOUGH public works officials have given the matter little attention, there is a right and wrong way for their refuse collection employes to lift and "tote" waste containers, according to a study made by the American Public Works Association. Resultant injuries often cost cities sizable amounts in workmen's compensation, and the matter is important in terms of efficient garbage collection and protection of the employe's health.

Inadequate instruction

"Some administrators contend that if a refuse collector is worth keeping, he will soon learn by himself the best and easiest ways to manipulate the containers," the study said. "In the main this is probably true, but it is also true that some valuable employes have been lost to the collection services because they were not given adequate instruction at the start. Either they find the work too strenuous or they strain themselves seriously through overexertion in trying to make a good impression the first few days on the job."

Most inexperienced refuse collectors make a mistake in bending over at the waist to lift a can from the ground, it was said. The proper method is to stoop by bending the knees, keep the back as vertical as possible, and rise with the load by straightening the knees.

Local conditions important

It is suggested that individual cities would find it profitable to determine through trials by experienced employes the one best method of lifting and carrying the particular type of refuse container used, so that the least time is lost and the least effort and strain are required. Differences in sizes and shapes of refuse cans, the weight of the refuse, and the hilliness or flatness of the ground are among factors that make it necessary for cities to conduct their own studies of the problem.

In a survey of various methods of transporting refuse from house holders' backyards to collection trucks, it was found that collectors in some parts of the country prefer to lift the containers to their shoulders or heads, while elsewhere they are carried on the hip. Sometimes they are carried by straps or just off the ground in a trailing position.

The current study is part of a complete survey which will cover all aspects of refuse collection and disposal methods in use by American cities, with recommendations for their improvement. Inquiries may be directed to the association at 1313 East 60 St., Chicago.

Design Economy by Connection Restraint

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***Contents in Brief**—Heretofore continuity in building framing has been taken advantage of infrequently because of a lack of information on the restraint values of beam-column connections. Laboratory work has now provided much of this information and a rational and workable design procedure has been developed. Beams are first designed for maximum moment assuming simple supports. Then the ratio of beam stiffness to the sum of column stiffnesses at the joint is calculated. Charts equating this ratio to the percentage rigidity give a reduction factor F, which is applied to the section modulus of the simple beam. The beam corresponding to this reduced section modulus is the one to use. It will be 15 to 20 per cent lighter than if assumed to be simply supported.*

THE DESIGN OF THE BEAMS in multi-storied steel building frames has usually been based on the simplifying assumption that the ends of the beam are freely supported. While this assumption leads to a safe design, economy is sacrificed since no account is taken of the reduction in maximum positive moment that results from the end restraint that is present even in the most flexible connections. It is notable that slight increases in the stiffness of standard types of end connections provide enough end restraint to reduce the average weight of beams in a building frame by 15 to 20 per cent.

Unfortunately the application to building frames of methods of analyzing continuous structures is exceedingly laborious, and furthermore, there has been considerable uncertainty as to just how dependable and to what degree a semi-rigid connection provides end restraint. Now, however, experimental evaluation of the behavior of various types of beam-column connections has furnished much of the information necessary for the design of rigid and semi-rigidly connected frames, and this article presents such a design method which may be applied to any building frame in which the minimum restraint values of the connections have been determined.

Background of the method

The possibilities of economy are greatest when there is a repetition of similar span lengths, load conditions and connection types. To demonstrate the possible economy, a study of 105 beam sizes for various uniform loads and degrees of restraint has been made by the writers, showing substantial saving in weight for handbook selection of beams, even for cases of small percentage rigidity. The beam sizes ranged from 12-in. 22-lb. sections to 21 in. 63-lb. sections, the spans from 16 to 24 ft., and the loads from 80 to 120 lb. per sq ft. of floor. Fig. 1 shows the average minimum savings for various percentage rigidities. The beams were designed by the method outlined in this article.

Correlated to the problem of beam design are the problems of connection design, column design, and analysis for wind stresses. Experimental work on connections and columns are now in progress at Lehigh with the specific problem of building design in mind. Experimental work on moment-resisting riveted and welded connections that has furnished much of the necessary information for this design method are listed in the bibliography at the end of this article.

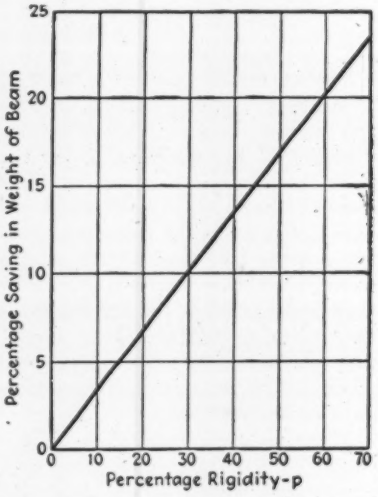

Fig. 1. Saving in weight of beams for various degrees of restraint from 105 trial designs.

The semi-rigid joint

Before discussing the design of beams, it is necessary to have a definition of the term, semi-rigid joint. If the beam-column connections of a building frame transmit bending moment without relative rotation between the end of the beam and the column, the connection and the structure are termed "rigid" (Fig. 2a). In such a case, the connections afford 100 per cent restraint or full continuity, and the maximum bending moments are at the ends of the beam. If the connections transmit bending moment with some relative rotation between the end of the beam and the column, the connections and the structure are termed "semi-rigid" (Fig. 2b). In such a structure, the connections resist bending moment to some degree less than in the case of full continuity, and the moment in the center of the span is always less than if the connection afforded no restraint, as in a simply supported beam (Fig. 2c).

The semi-rigid joint, such as the standard beam web connection, the top and seat angle connection, and the split-I connection thus results in a restraint somewhere between full fixity and full freedom of rotation. It is important to note that 100 per cent restraint does not afford the greatest possible economy in building construction, largely because the cost of making the rigid connection tends to overbalance the saving in beam cost. Maximum economy for beam and connections usually occurs

at a degree of restraint somewhere between 40 and 75 per cent.

The joint constant

A typical graph of the test of a semi-rigid connection is shown in Fig. 3 in which applied connection moment is plotted against relative column-beam end rotation. The connection passes through three stages: first, an initial stage where moment is approximately proportional to rotation; second, a yielding of the connection; and third, a stage of accelerated rotation finally resulting either in failure or very excessive deformation.

The first stage is the useful design range of the connection. It is especially important that the connection also have a sufficient factor of safety with respect to rotation. The maximum rotation which a semi-rigid connection approaches is the simple-beam end slope, and this occurs well within the rotation at failure for all semi-rigid connections except a few having very high rigidities. In these few cases, the working moment must be based on the ultimate moment.

The experimental determination of one factor is necessary as a basis for the design method. This is the connection constant, J, which may be defined as:

$$J = \frac{M}{E\phi} \qquad (1)$$

where ϕ is the rotation due to an applied moment M and E is Young's modulus. Physically, the joint constant is the slope of the first stage of the moment-rotation curve divided by the modulus of elasticity of the material. It is a measure of the connection stiffness. A connection, therefore, whose joint constant J is large is more rigid, or has more moment-taking ability within its working capacity, than one whose joint constant is small.

The percentage rigidity, p, depends on the connection constant J and the stiffness of the beam K, which is the gross moment of inertia of the cross section divided by the span length.

$$p = \frac{100}{1 + 2\frac{K}{J}} \qquad (2)$$

The percentage rigidity, then, is fixed when the connection and the beam size are chosen.

Fig. 4 is plotted from Eq. 2 and shows the relation between the joint constant and the percentage rigidity for various values of beam stiffness in the case of a beam fastened to rigid walls by semi-rigid joints. Most building beams have a stiffness of 0.5 to 5.0. It may be seen that in the design range of p less than 70 per cent, a considerable variation in the connection constant J has little influence on the percentage rigidity p. For instance, in the case of a beam of stiffness $K = 1.5$ and $J = 10$, the reduction of the connection stiffness J by 100 per cent to 5 would change the span-end moment less than 20 per cent.

It follows that while differences in welding or riveting processes may affect the value of J considerably there will be relatively much less variation in the actual beam moment. It also follows that a range of permissible variation in connection behavior, as shown in Fig. 3, should be allowed for any typical connection to take care of variations in fabricating as well as non-uniform relationship between moment and relative angle change.

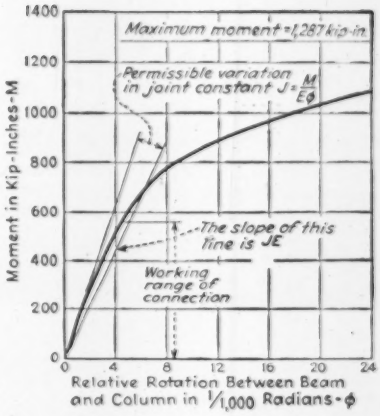

Fig. 3. Typical test curve of a semi-rigid connection. It will be noted that variation in joint constant does not greatly affect the moment that can be carried.

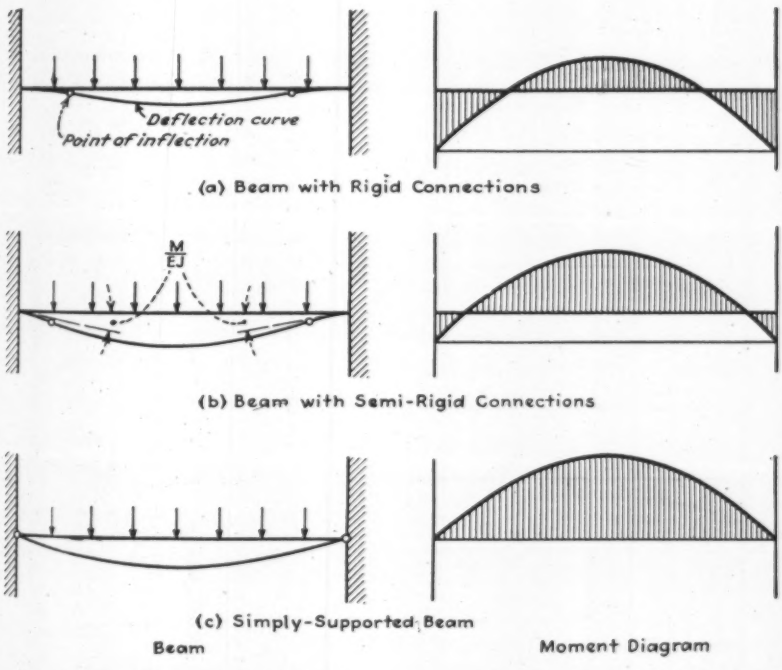

Fig. 2. Beam with different conditions of end restraint, showing how bending moments vary at the center and at the supports.

Proposed design method

The proposed method of design is one that proportions the connection for the semi-fixed end moment which would occur if the columns did not rotate, and proportions the beam for maximum center moment which occurs when the columns do rotate.

In order to develop a direct method of design the beams in spans adjacent to that under consideration will be neglected. The approximation is on the side of safety and also allows the method to be applied to outside panels which have no adjacent beams. Fig. 5a shows the most critical load condition for maximum moment in beam AB, and Fig. 5b shows the same beam with adjacent beams

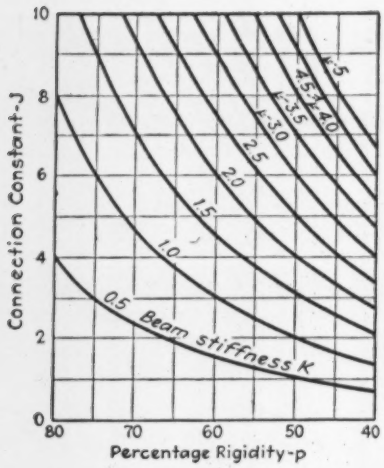

Fig. 4. Relation between connection constant and percentage rigidity.

omitted. Symmetrical conditions of load, connections, and adjacent columns are assumed to exist. Connections of 50 per cent rigidity are assumed in the following derivation.

The ordinary relation between the moment at the end A of a beam, AB, and the angle changes at its two ends is;

$$M_{AB} = 2EK(2\theta_A + \theta_B) \pm M_R \quad (3)$$

where M_R is the fixed end moment in a fully rigid connection.

When semi-rigid connections providing 50 per cent rigidity are introduced the equation becomes:

$$M_{AB} = EK(1.25\theta_A + 0.25\theta_B) \pm \frac{M_R}{2} \quad (4)$$

Due to symmetry, $\theta_A = -\theta_B = -\theta_C$

Hence:

$$M_{AB} = EK\theta_A - \frac{M_R}{2} \quad (5)$$

The moments acting on the joint must be in static equilibrium, hence:

$$M_{AB} + 2M_{AC} = 0 \text{ (since } M_{AC} = M_{AE}) \quad (6)$$

Substituting (4) and (5) into (6) there results

$$\theta_A = \frac{M_R}{2}\left(\frac{1}{4EK_C + EK_B}\right) = \frac{M_R}{2}\left(\frac{1}{2E\Sigma K_C + EK_B}\right) \quad (7)$$

Subscripts C and B in Eq. 7 refer to columns and beam, respectively.

Substituting (7) into Eq. (5), there results

$$M_{AB} = -M_R\left(\frac{1}{2 + \frac{K_B}{\Sigma K_C}}\right) \quad (8)$$

The moment at the center of the beam is given by

$$M_C = M_S + M_{AB}$$

$$= M_S - M_R\left(\frac{1}{2 + \frac{K_B}{\Sigma K_C}}\right) \quad (9)$$

For rigidities equal to or less than 75 per cent the center moment is maximum and will govern the design of the beam. In the design procedure the beam is first designed as a simple beam, freely supported. The required simple beam section modulus is then multiplied by a reduction factor F which gives the section modulus required for the worst condition of loading but which takes advantage of the semi-rigid connections.

$$F = \frac{\text{Section modulus required by proposed method}}{\text{Section modulus required for simple beam}} = \frac{M_C}{M_S}$$

Hence:

$$F = \frac{M_C}{M_S} = 1 - \frac{M_R}{M_S}\left(\frac{1}{2 + \frac{K_B}{\Sigma K_C}}\right) \quad (10)$$

The reduction factor F, then, is the factor by which the simple-beam section modulus is multiplied to obtain the required section modulus for the beam. The ratio M_R/M_S depends on the type of load.

Eq. (10) was evaluated for end connections providing 50 per cent rigidity; similar equations have been derived for other rigidities. In Figs. 6, 7, and 8, charts are shown which give the reduction factor for various types of loads and percentage rigidities.

The design procedure

The following design procedure is based upon the assumption that data are available which give the dependable end restraint value, or "percentage rigidity", of any standard connection. Such values have already been evaluated for a limited number of connection types. Tests now in progress at the Fritz Laboratory sponsored by the American Institute of Steel Construction will supplement previous work on riveted connections by J. Charles Rathbun[3] in this country and by J. F. Baker[4], C. Batho[5] and others in England. The combined results of these tests should establish dependable criteria for riveted connections. In the welding field, highly rigid connections have been tested[6], but in the semi-rigid class only the seat and top angle type has been studied in detail[7]. Further work is needed on various types of welded connections.

It is important to note that, in spite of the present lack of established standards, the application of this design procedure may be made to any particular building design through the expedient of actually testing typical proposed connections to be used in the structure.

The actual details of the design procedure may be outlined as follows:

1. Design the beams for maximum bending moment assuming simple supports.

2. Calculate $K_B = \frac{I_B}{l_B}$ for the beam and $\Sigma K_C = \Sigma\frac{I_C}{l_C}$ for the columns above and below one end of the beam.

3. Determine the ratio of $\frac{K_B}{\Sigma K_C}$

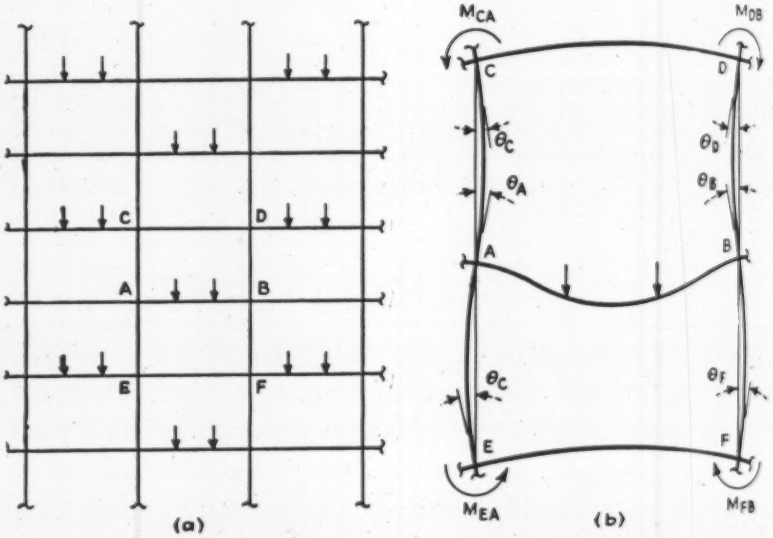

Fig. 5. Analysis of semi-rigidly connected frame for critical loading condition.

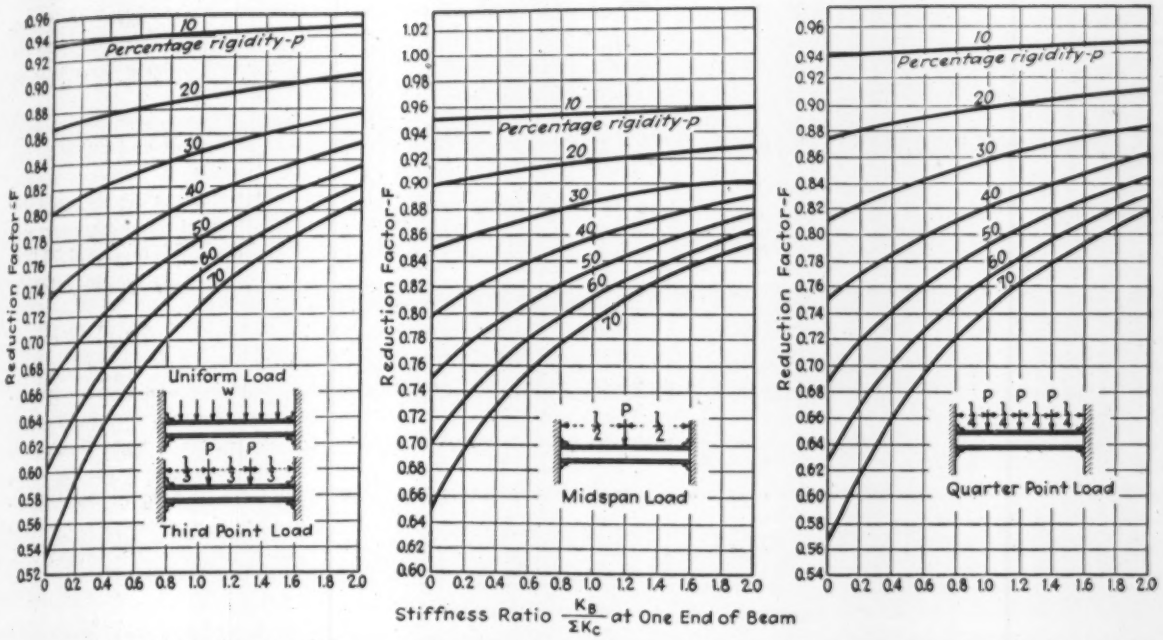

Fig. 6. Reduction factor F for four different types of loading. Abscissas are ratios of beam and column rigidities at a joint.

decide on the percentage rigidity to use in design, and determine from Figs. 6, 7, or 8 the reduction factor F for the existing load condition.

4. Multiply the section modulus required for simple-beam design by the reduction factor F, and redesign the beam on the basis of the reduced modulus.

5. Calculate the semi-rigid end moment for the condition of all beams loaded by multiplying the fixed end moment by the per cent rigidity assumed.

6. Select a connection on the basis of end reaction, semi-rigid end moment, and percentage rigidity assumed.

In step 2 the stiffness of the beam, K_B, is based on the simple beam design. K_B could be based upon the reduced I_B of the final design, but since this is not known the approximation provides a direct design procedure and is on the side of safety. However, if a particular beam size is repeated under identical loading conditions a great number of times a further economy would be introduced by estimating K_B as 80 to 85 per cent of K_B for simple beam moment and verifying the estimate after the beam is designed on the basis of reduced moment. One trial design would be the most that might be required.

If the column sizes are not the same at each end the design may be based on the more flexible end with the approximation again on the side of safety. If the loading condition is moderately unsymmetrical, the end moments may be approximated at each end by Eq. 8, and the approximate bending moment diagram for the beam constructed. The severe loading condition assumed in Fig. 5 and the extreme improbability of its occurrence renders meaningless small errors of a few per cent which might be introduced by applying Eq. 8 to unsymmetrical conditions.

In step 3 the decision regarding what per cent rigidity to use in design may be made arbitrarily, but after a little practice its selection will be based on questions of feasibility, economy, and preference for a particular connection type. The final design of the connection in step 6 ultimately may be made simply by reference to standardized connection tables which give safe values of shear, moment, and percentage rigidity. At present the selection must be based on existing experimental data available in the publications listed in items 2, 3, 4 and 7 of the accompanying bibliography.

The design procedure may be illustrated as far as beam selection is concerned by an example. It is desired to select a beam, having 50 per cent rigid connections for a uniform load of 2 kips per ft., a span of 20 ft., and framing into the flanges of 10-in 49-lb. WF 49 columns of 10 ft. story height.

The simple beam moment is:

$$M_S = \frac{(2)(20^2)}{8} = 100 \text{ kip-ft.}$$

$$= 1200 \text{ kip-in.}$$

$$S = \frac{M}{f} = \frac{1200 \text{ kip-in.}}{20} = 60 \text{ in.}^3$$

f = allowable working stress in kips per sq. in.

For a simple beam, a 16-in. 40-lb. WF beam would be required with $I = 515.5$ in.^{4}

$$K_B = \frac{515.5 \text{ in.}^4}{240 \text{ in.}} = 2.15 \text{ in.}^3$$

$$\Sigma K_C = 2\,\frac{272.9 \text{ in.}^4}{120 \text{ in.}} = 4.55 \text{ in.}^3$$

$$\frac{K_B}{\Sigma K_C} = \frac{2.15}{4.55} = 0.47$$

From Fig. 6, for $p = 50$ per cent. $F = 0.73$
Required $S = (0.73)(60 \text{ in.}) = 43.8 \text{ in.}^3$
Use a 15-in. 33-lb. M-beam
Saving = $40 - 33 = 7$ lb. or 17.5 per cent

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Danger Ahead! Sewage Gas Hazards

***Contents in Brief** — Asphyxiation and gas poisoning hazards at sewage disposal plants may originate at a number of points in the treatment process. Where the danger zones are located and what precautions to take are discussed in the following abstract.*

EXPLOSIONS, asphyxiation and poisoning are gas hazards experienced in maintenance work on sewers and in the operation of sewage treatment plants. At the sewage works school held in March by Purdue University and the Indiana State Board of Health this particular aspect of occupational hazards was discussed by John S. Wiley, engineer of the state bureau of industrial hygiene. Much has been published with reference to explosions at sewage treatment plants, but comparatively little data are available relating to the other kinds of gas hazards, except as to their medical significance. The following abstract, therefore, is confined to asphyxiating or poisonous if present

It was stated by Mr. Wiley that any gas, except oxygen, whether explosive or non-explosive, may be asphyxiating or poisonous if present in sufficient quantity. A non-poisonous gas may be asphyxiating if it displaces the oxygen in the air to such an extent that there is not enough left for proper respiration or circulation in the blood.

Asphyxiating gases

Asphyxiants commonly found in sewers or at sewage treatment plants are of three general classes:

(1) Gases which merely displace the oxygen, including methane, natural gas, nitrogen and hydrogen. Methane is the principal one, and may be found anywhere in a sewerage system if conditions are favorable. Natural or manufactured gas may be present in sewers as a result of leakage from mains, but generally they will not be present at the plant, at least beyond the primary treatment stage. Nitrogen and hydrogen are rarely produced from sewage or sludge in sufficient quantity to be asphyxiating.

(2) Carbon dioxide combined with partial oxygen deficiency. Some carbon dioxide is exhaled in breathing and if the concentration builds up in the body sufficient carbon dioxide cannot be eliminated by the blood due to the high carbon dioxide content of the inhaled air.

(3) Carbon monoxide may be considered as a poison, because a very small amount may be fatal, but it really acts as an asphyxiant, even though the oxygen content of the air is not deficient. A proportion of 100 ppm is considered safe for several hours, while 500 is the maximum safe limit for one-hour exposure; 1,500 to 1,800 ppm, or 0.15 to 0.18 per cent is considered fatal in less than an hour.

Methane, carbon dioxide and carbon monoxide are normal constituents of sludge gas; some nitrogen and hydrogen may also be produced. Other gases (usually illuminants, such as ethylene) may be produced, but are usually simple asphyxiants, like methane. Normally, 95 per cent of sludge gas is methane and carbon dioxide, with the methane content varying from 50 to 90 per cent. The mixture of gases may be fatal even if the limits of safety are not reached for each gas.

Poisonous gases

Many poisonous gases may be found in sewers and at sewage treatment plants, the most common being hydrogen sulphide, carbon monoxide (previously classed as an asphyxiant), chlorine, and gasoline vapors. Others include ammonia, phosgene, carbon tetrachloride vapor, sulphur dioxide, acrolein, and other gases which may come down with trade wastes.

Hydrogen sulphide at 500 to 600 ppm will produce fatal poisoning in an exposure of less than an hour, and is dangerous for long exposure in concentrations as low as 50 ppm. Though it can be detected at 2 to 20 ppm by its "rotten egg" odor, the nose may become accustomed to this and so fail to warn of a dangerous concentration.

Carbon monoxide may be produced in sludge and septic sewage; it is present in coal gas (4 to 10 per cent), water gas (30 to 40 per cent), and automobile exhaust gas (6 per cent); these gases may leak into sewers and cause trouble. As the monoxide is also a product of incomplete combustion, it may be present around gas-burning equipment.

Gasoline vapors are toxic, and with their explosion and fire hazards produce dangers in sewer systems. About 300 ppm can be detected by odor; 1,000 ppm is dangerous for exposure of several hours, and 11,000 to 22,000 ppm may prove fatal in less than an hour.

Chlorine, used at the plant or applied in the sewers, is one of the most toxic poisons and has also an irritating action on the respiratory tract and the lungs. At 1 ppm it may be detected by a burning of the eyes, but since the eyes may become accustomed to it, a dangerous concentration may not be noticed. In less than fatal doses it may cause chronic poisoning.

Ammonia, which may be present in sewage or sludge, may be detected by odor at 80 ppm; it becomes dangerous for long exposure at 100 ppm, and is fatal in less than an hour at 1,500 to 3,200 ppm. Phosgene is a very toxic irritant poison usually encountered in fires where chlorine or carbon tetrachloride may be present. It is more toxic than chlorine and not so easily detected. Carbon tetrachloride vapor is toxic, as are most chlorinated hydrocarbon vapors. The worst danger, however, is from the formation of phosgene in fighting fire with carbon tetrachloride or pyrene in a fire extinguisher.

Sulphur dioxide, a product of combustion of any fuel containing sulphur, is an irritant and highly toxic poison. Sludge gas containing hydrogen sulphide will form sulphur dioxide on combustion, which is one reason for ventilating gas-burning equipment. The sulphur dioxide may also be present in the sewer system as a result of trade wastes from industries where it is used as a bleach, preservative or refrigerant. It usually gives ample warning, as it has a sharp penetrating odor at 5 ppm, causes coughing at 10, and burning of the eyes at 20 ppm.

Acrolein is an extremely toxic gas which may result from the burning of grease, scum or screenings at the plant, or from the burning of sludge gas if the sludge contains these materials in large quantity. At 1 ppm it is dangerous for several hours' exposure, and is fatal at 25 ppm in less than one hour.

Controls for gas in the sewer system should include the following: (1) frequent cleaning and flushing of sewers to prevent gas formation; (2) ventilation of sewers and manholes (preferably with portable blowers) before men enter; (3) use of detectors, such as explosimeters, carbon monoxide indicators and hydrogen sulphide detectors; (4) wearing of personal protective devices. Air line respirators or oxygen masks provide protection against all asphyxiating or poisonous gases. Gas masks of all-purpose type, approved by U. S. Bureau of Mines, protect against most poisonous gases (unless present in excess amounts), but not against a deficiency of oxygen.

Controls for gas at a sewage treatment plant should include the following: (1) frequent flushing of pits, sumps and screen chambers to prevent formation of gas due to septic action; (2) ventilation of gas burning equipment, chlorinator rooms, storerooms for chemicals and chlorine cylinders, and fume hoods in the laboratory; (3) purging of digestors, sumps, Imhoff tanks and similar areas before men enter them; (4) frequent inspection and maintenance of gas seals, traps, pipes, meters, gages and burning equipment; (5) use of alarms for poisonous gas, explosive gas and oxygen deficiency; (6) use of such detectors as canaries, explosimeters, hydrogen sulphide detectors, carbon monoxide indicators and chlorine leak detectors; (7) wearing of personal protective devices such as air line respirators or hose-connected masks, oxygen and gas masks, and safety belts.

Handling Chlorine Leaks

What to do when a chlorine tank leaks is solved in different ways. In Chicago some of the safeguards are as follows: Fans are provided to change the air in the chlorine rooms in one minute; for small leaks a water ejector made of duriron exhausts the gas from a hood over the leak and discharges into a drain; when a large leak occurs the cylinder may be lowered by an electric monorail hoist into a tank containing enough caustic solution to neutralize 50 per cent more chlorine than in a full ton container. As containers with 500 to 700 lb. of chlorine in them will float, provision is made to weight them down.

Outside Rods Hold Semi-circular Concrete Form Without Interior Ties

THE SPILLWAY SECTION of Guntersville Dam on the Tennessee River required high slender piers for the gate structure and to support the operating bridge. The upstream end of the 8-ft.-wide pier is a semicircle. General form design called for 10-ft. lifts of concrete with two rings of forms used, the lower one being "jumped" and supported on the top ring for the next lift of concrete.

Panel forms of unusually heavy construction were used throughout the work, the standard size being 42 ft. by 10 ft. and weighing 6 tons. Heavy equipment was available for handling and excellent lines and surfaces were obtained.

To insure good lines on the rounded nose and to simplify erection, the form for the semicircular nose was designed to be held with rods circling the exterior of the form, much like rods around a wooden tank. As shown in Fig. 2, the ends of the rods were tied into the 42-ft. side panel, which also held the opposite thrust of the downstream form. Design was based on filling at 4 ft. per hour and maximum pressure of about 700 lb. per sq.ft.

Tension on rods = d h P
in which

d = diameter
h = height
P = concrete pressure
} per unit area

Heavy vertical wales required the use of only two rods spaced to connect with the existing wales of the side panel forms. No interior ties were used in the nose form.

Resultant concrete was free from the usual breaks around rods set at an angle, and forms required no repairs as they stripped easily rather than being pulled off over rods.

The form was designed by C. C. Cullum, then office engineer, from the suggestion of E. P. Fowler, assistant general carpenter foreman, of Gunterville Dam Construction Department of TVA. Geo. P. Jessup was construction superintendent and Verne Gongwer, project engineer.

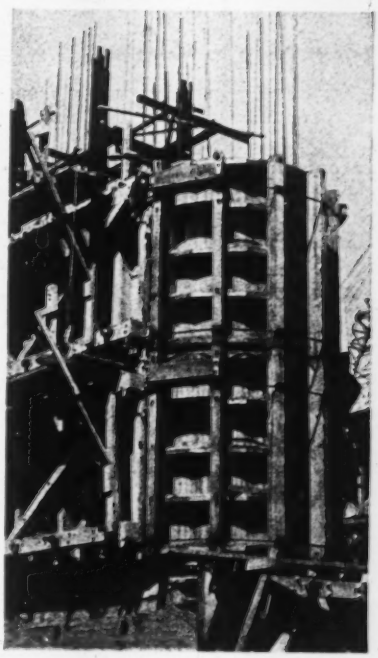


Fig. 1. Bottom "lifts" of rounded nose form. Note that circular rods attached to side panel forms carry entire load.

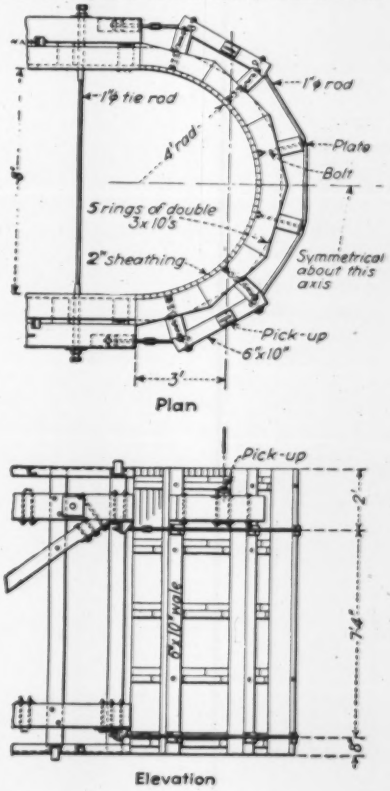


Fig. 2. Nose form, 8-ft. diameter. Two 1-in. rods carry load of 10-ft. lift of concrete.

From Field and Office

Working problems and time-saving methods for engineers and contractors

Brings Shop to Machine

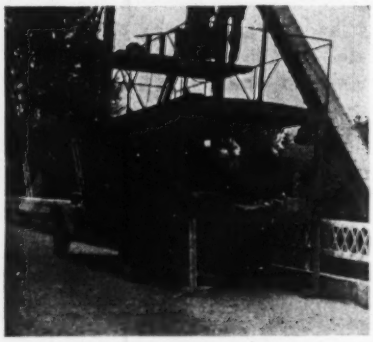
Ordinarily in repairing contractors' equipment, the machine is brought to the shop. Growing out of an observation that high-priced machinists spent 2 hr. a day walking back and forth from a shop 150 ft. from the repair yard, Donald B. MacNeal, renter and repairer of heavy machinery and used equipment, conceived the idea of fitting up a shop in a boxcar and bringing the shop to the machine. He bought a standard automobile car, 40 ft. long and 10 ft. high with double doors, and has equipped it (see illustration) with sufficient tools and parts to make in the field all ordinary repairs on a crane, shovel or other heavy machine. The car has the latest MCB trucks and can be dispatched to any part of the country by rail.

In one end of the car on one side is a Model A Ford engine belted to a line shaft to drive a hacksaw, grinder and buffer, drill press, compressor and lathe. On the other side is a work bench with vise and on the walls are tools, mostly wrenches arranged according to size. In the opposite end of the car, one side is taken up with small parts for cranes and the other with a large array of bins for bolts, nuts and small standard parts. A grease barrel is located at the end and a bench with pipe vise on the other side. In the center is an anvil and forge and for winter use a depot coal stove is provided.

Portable Electric Welder

Changes in the bracing of end portals on steel highway bridges have been made by the Oregon State Highway Commission to eliminate impaired clearances. By use of a 200-amp.-hr. electric welding outfit mounted on a 1½-ton truck, the structural changes are made by a crew of two.

It has been possible in most cases to cut out with an oxyacetylene torch the knee brace that was in the way and then to cut this brace to the proper length and weld it back into the portal bracing system in such a way that it would afford adequate stiffness without interfering with desirable clearances.

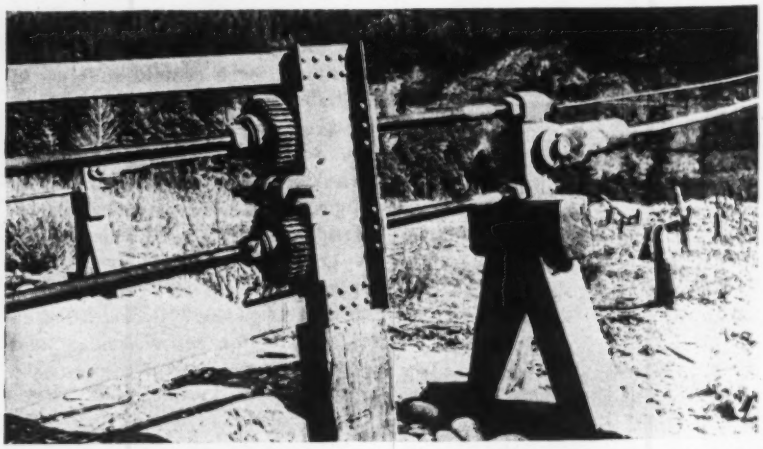


Camera Memoranda

A coil of pipe through which hot water is circulated prevents freezing of the wet contents in the ash storage bin at the Schenectady incinerator during cold weather. The 35-cu.yd. metal bin receives ashes from the quenching trough and the ash is removed by truck. The pipe coils surrounding the discharge neck of the hopper are connected with the circulating hot water heating system used in the incinerator.

Cable Tension Adjusting Device

A device for adjusting tension and length in 1¾-in. cables used to support a transporter ferry at North Bend, B. C., consists of the simple arrangement shown in the picture below. By using hand cranks on both ends of the worm gear shaft, a balanced, two-man-power operation is obtained. There are two cables, 20 ft. apart, each with its own adjustment mechanism.



Cranks on the projecting ends of the worm gear shaft make it easy to adjust this cable on a transporter bridge.

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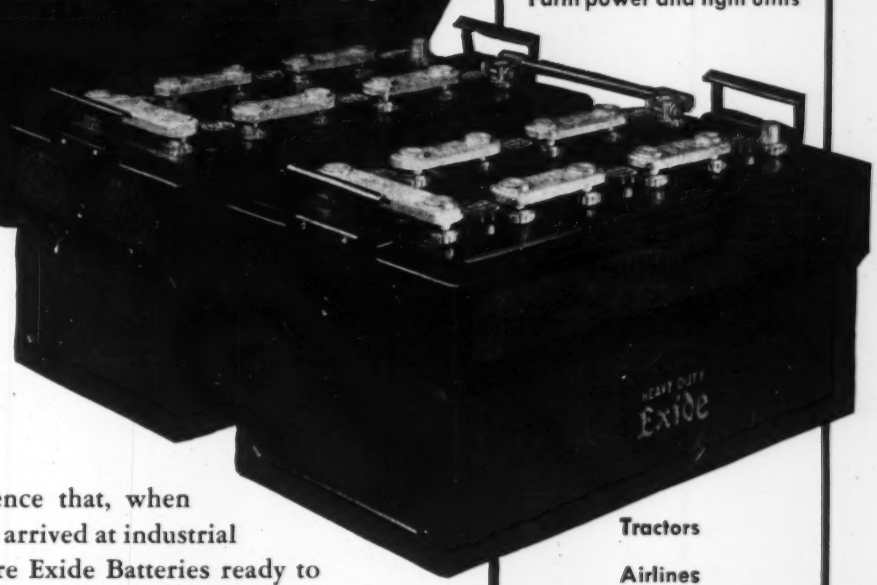

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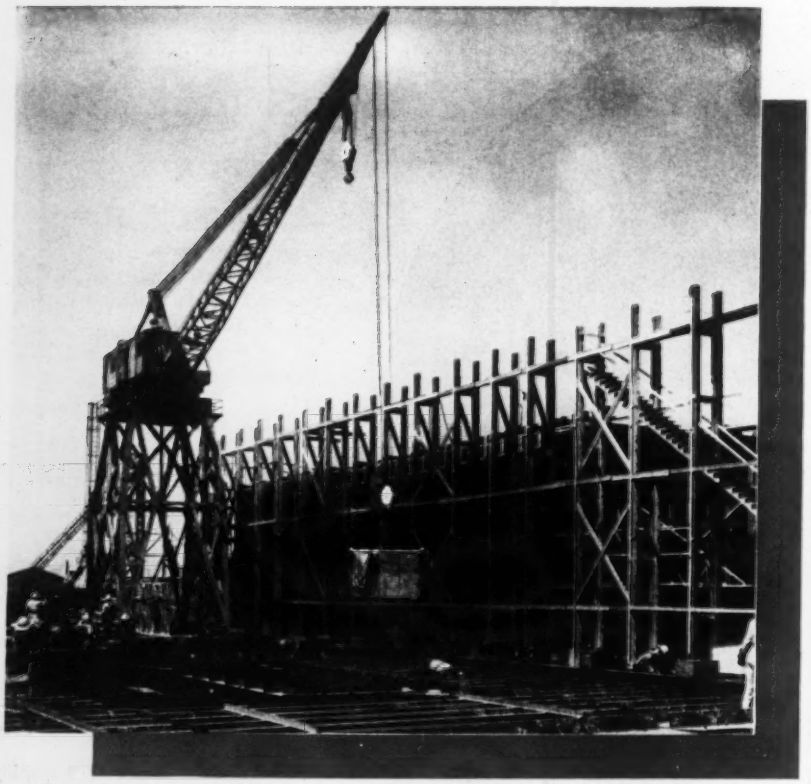

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JAMES H. LE VAN, civil engineer, U. S. Public Health Service, is now stationed at Bethesda, Md., in the Division of Industrial Hygiene of the National Institute of Health. As officer in charge of the motorized Aedes Aegypti Control Unit, Le Van took the unit in convoy from Brownsville, Tex. to Miami Beach, Fla., where it was disbanded. He had been in charge of control surveys of *Aedes aegypti* mosquitoes during the past two years in prevention of the introduction of yellow fever into the United States. He continues as a commissioned officer in the U. S. Public Health Service with the rank of passed assistant sanitary engineer.

RAY C. EWALD has been succeeded as president of the Minneapolis city planning commission by O. E. ERICKSON. Erickson's old position of vice president has been filled by F. H. STEVENS; Stevens' old work as secretary of the organization has been taken over by J. A. BRUNET.

ALVIN ROGERS MOORE, architect of Atlanta, Ga., has been called to active duty as Construction Quartermaster at Camp Jackson, S. C. His Atlanta office will be closed during the present national emergency. Moore, having been an officer in the Reserve Corps, will now serve as a captain in the regular army.

DAVID M. MACALPINE, during the past year a member of the civil engineering faculty at Robert College in Istanbul, Turkey, has returned to the United States to begin new duties as instructor in civil engineering at the College of the City of New York.

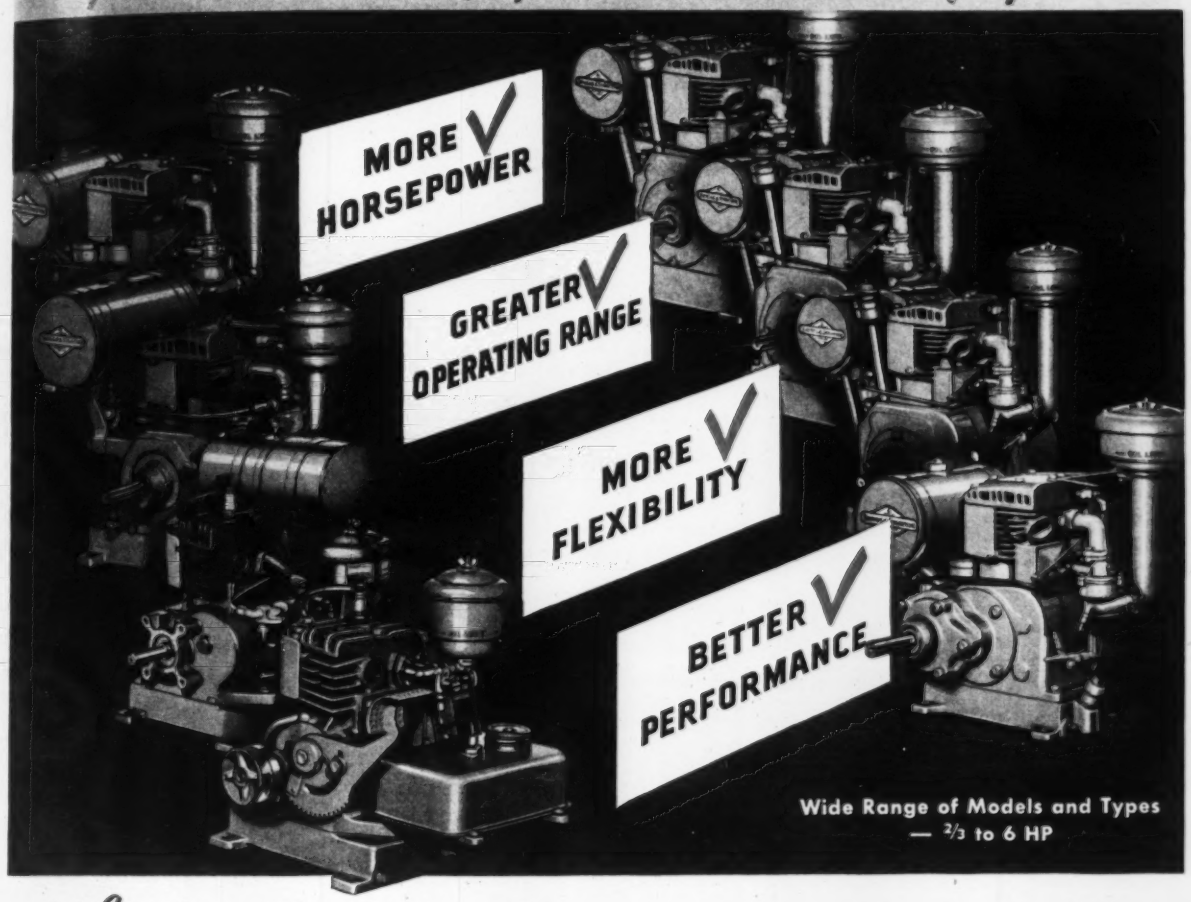
J. W. HUBLER, a former engineering instructor at Purdue University, has been appointed assistant professor of civil engineering at Alabama Polytechnic Institute. Previous to teaching at Purdue, Hubler spent four years with the Indiana State Highway Department. He holds two civil engineering degrees from Purdue.

F. M. DAWSON, dean of the college of engineering at the University of Iowa; T. R. AGG, dean of the Iowa State College engineering department, and WILLIAM L. PERKINS, secretary of the Iowa state board of architectural examiners, have been named as a three-man board to survey requirements for a new Iowa state office building in Des Moines.

LACEY V. MURROW, state highway director of the Washington State Highway Department, has been given an indefinite

(*Continued on p. 94*)

Buyers and Sellers of Gasoline Powered Equipment



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MATERIALS AND LABOR PRICES

Market quotations on construction materials and wage rates reported monthly by ENR correspondents

LUMBER price increases again provide the major change in the construction material field for October. Short Leaf Yellow Pine is up $5.00 to $9.50 per M ft. in Atlanta; up $1.00 on 1x6-in. size in Chicago; up $1.50 to $2.00 in Cleveland; up $2.50 to $5.50 in Dallas; up $2.00 to $8.00 in Kansas City; up $1.00 to $3.00 in New York; and up $3.00 to $8.00 in St. Louis. Douglas Fir is $2.00 higher in Boston; 50c. to $1.75 higher in Kansas City; $1.00 higher in New York; and $1.50 higher in Minneapolis. The lumber prices in Montreal have been set at the level which prevailed in June, 1940 by order of the Dominion Controller of Lumber. These prices will extend through the balance of the year. Form grade plywood manufacturers, in many cases, are out of the market as a result of the rush of defense orders.

Aside from lumber, only minor changes are reported for October. Sand and gravel are 25c. per ton lower in Dallas; and crushed stone is up 5c. per ton in St. Louis. Ready-mixed concrete is 25c. per cu.yd. higher in Baltimore. Red lead increased 25c. per 100 lb. in all of the *ENR* twenty cities.

Reinforcing bars are up 15c. per 100 lb. in Los Angeles, and 7½c. higher in San Francisco for the only changes in the construction steel list.

Labor rates in both the common and skilled construction groups are unchanged from September. In Seattle a change in the length of the working week has taken place; an 8-hour day, 40-hour week supplants the former 6-hour day, 30-hour week.

CEMENT, AGGREGATES, READY-MIXED CONCRETE—F.O.B. CITY

	PORTLAND CEMENT			SAND AND GRAVEL			CRUSHED STONE		CRUSHED SLAG		CONCRETE
	Per bbl., carload lots, including 40c per bbl. for bags, cash discount not deducted			Per ton, carload lots			Per ton, carload lots		Per ton, carload lots, f.o.b. plant		Ready Mixed 1:2:4, 50 c.y. or more, delivered
	Cloth Bags *a*	Paper Bags	Bulk	Gravel, 1½ in.	Gravel, ¾ in.	Sand	1½ in.	¾ in.	1½ in.	¾ in.	
Atlanta	$2.90	$2.66	$2.61	$1.75	$1.85	$1.95	$1.65	$1.75	$1.55	$1.65	$7.90
Baltimore	2.31	2.06	1.86	1.70‡	1.70‡	1.20‡	1.75‡	1.75‡	1.75‡	1.75‡	6.75
Birmingham	2.50	2.25	2.05	1.75	1.75	1.50	1.00	1.00	.90	1.15	5.80
Boston	2.75*b*	2.50*b*	2.30	1.20‡	1.20‡	.90‡	1.20‡	1.20‡	....	....	6.75*m*
Chicago	2.60	2.35	2.20	2.00‡*d*	2.00‡*d*	2.00‡*d*	2.00‡*d*	2.00‡*d*	1.25‡	1.25‡	....
Cincinnati	2.58	2.33	2.08	1.20	1.20	1.10	1.80	1.80	....	....	6.60
Cleveland	2.00	1.75	....	1.45*i*	1.45*i*	1.30*i*	1.70*i*	1.70*i*	1.70*i*	1.70*i*	6.55*i*
Dallas	2.30	2.05	1.85	1.75*p*	2.00*p*	1.25*p*	1.69*p*	1.84*p*	....	....	6.20
Denver	3.02	2.77	....	1.20	1.40	.90	....	....	....	....	7.25
Detroit	2.23	1.98	1.78	1.30	1.40	.80	1.30	1.45	1.02‡	1.14‡	6.50
Kansas City	2.56	2.31	2.16	1.85	2.30	1.00	1.91	1.91	....	....	7.25*n*
Los Angeles	2.25*b*	2.05*b*	....	1.00	1.00	1.00	1.00*f*	1.00*f*	....	....	5.85
Minneapolis	2.90	2.65	....	1.00*h*	1.00*h*	.25*h*	1.00*h*	1.00*h*	....	....	7.35*j*
Montreal	....	1.82*r*	1.67*r*	....	....	1.25‡	.85‡*c*	1.00‡*c*	....	....	6.45*l*
New Orleans	2.41	2.16	1.96	1.50	1.50	1.25	....	....	....	....	7.25
New York	2.60‡	2.35‡	....	1.25*de*	1.25*de*	.75*de*	1.65*de*	1.75*de*	....	....	6.75
Philadelphia	2.32	2.07	1.87	1.55‡	1.65‡	1.25‡	....	....	1.00	1.00	7.95*k*
Pittsburgh	2.44	2.19	1.99	1.40‡	1.40‡	1.70‡	2.25‡	2.25‡	1.50	1.50	7.50
St. Louis	2.55	2.30	....	1.50‡	1.50‡	1.25/1.50‡	.90*h*	.90*h*	.75*g*	.75*g*	7.50
San Francisco	2.16	1.96	1.66	1.36	1.36	1.36	1.46	1.46	....	....	6.95
Seattle	2.95*o*	2.70*o*	....	1.00*o*	1.00*o*	1.00*o*	2.00*o*	2.00*o*	....	....	7.25

‡ Delivered. *a* 10c. allowed for each returnable bag. *b* 10c. per bbl. off for cash. *c* Plus municipal tax. *d* Per cu. yd. *e* Barge lots alongside docks. *f* Crushed granite. *g* F.o.b. Granite City, Ill. *h* F.o.b. plant. *i* Within three miles of Public Square. *j* 5% discount for cash. *k* Discount 35c. 500 to 2000; 70c. 2000 to 5000; 95c. over 5000. *l* Up to 200 cu. yd. *m* 50c. off for cash. *n* 25 c.y. or more. *o* 2% off for cash. *p* 10c. per ton off, cash 15 days. *r* 10c. per bbl. off, cash 20 days.

CASH DISCOUNTS CEMENT to Contractors: truck delivery, 2% for cash on 10th of month; on carload deliveries, no trucking, same as dealer cash discount 10c. per bbl. for payment within 15 days of date of invoice. Subject discount 10c per bbl. 20 days in Montreal.

CURRENT MAXIMUM PRICES RECEIVED AT CEMENT MILL

Charge for bags not included. For cloth bags, add 40c. per bbl.; 10c. refund allowed for each returnable bag; for paper bags add 15c. per bbl., not refundable.

	Bagged	Bulk		Bagged	Bulk		Bagged	Bulk
Buffington, Ind.	$1.70	$1.65	Ironton, Ohio	$1.60	$1.55	Richard City, Tenn.	$1.80	$1.75
Dallas, Tex. (Inc. 5c. tax)	1.80	1.75	Limedale, Ind.	1.70	1.65	Steelton, Minn.	1.80	1.75
Hannibal, Mo.	1.70	1.65	Norfolk, Va.	1.65	1.60	Universal, Pa.	1.65	1.60
Hudson, N. Y.	1.75	1.70	Northampton, Pa.	1.55	1.50	Waco, Tex. (5c. tax in Tex.)	1.75	1.70
Independence, Kans.	1.70	1.65	North Birmingham, Ala.	1.70	1.65	Montreal	1.55	1.55

PAVING BRICK, BLOCKS, ASPHALT, ROAD OILS—F.O.B. CITY

	PAVING BRICKS AND BLOCKS			PAVING ASPHALT		ASPHALT BINDERS—FLUXES		CUTBACK ASPHALT		ROAD OILS	ASPHALT EMULSION (Quick-breaking)	
	Granite per M. lots of 50,000 4x4x8 in.	Brick per M. 3¼x4x8½ in. carload lots	Wood per sq. yd. 3½ in. 16-lb. treat	Per ton, less than 80 penetration		Per gal., 80-300 penetration		Per ton		Per gal.	Per gal.	
				Tank car	Drums	Tank car	Drums	Tank car	Drums	Tank car	Tank car	Drums
Atlanta	$73.00	$39.35	$2.25	$17.30*e*	$23.83*e*	$0.0695*e*	$0.1018*e*	$0.0734*he*	$0.1257*h*	$0.0634*e*	$0.0734	$0.1257
Baltimore	150.00‡	45.00‡	2.75	14.00	20.00	.06	.09	.065*h*	.115*h*	.....	.....	.....
Birmingham	.....	27.50‡‡	....	18.20	23.20	.0747	.1047	.0834*h*	.1484*h*	.....	.....	.....
Boston	90.00	47.50	3.25	14.00	20.00	.06	.09	.065*h*	.115*h*	.....	.09‡	.12‡
Chicago	140.00	50.00	1.80*d*	14.50	18.50	13.00*g*	17.00*g*	.06*h*	.09*h*	.04	.09	125
Cincinnati	112.00	37.50	....	13.50	17.50	.10	.....	16.80	.....	.0525	.....	.075
Cleveland	110.00	37.50	2.80	15.50	20.50	.065	.075	.075*h*	.085*h*	.0375	.08	.09
Dallas	.....	30.00	....	13.25	20.30	.06	.103	15.00	24.00	.055	.05/.07	07/.09
Denver	.....	27.50	....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Detroit	.....	35.00	....	13.15*f*	18.45*f*	.061	.0984	13.15	17.20	.0475	.061	.0923
Kansas City	.....	40.00	....	18.50	23.50	.077	.1075	.077*h*	.107*h*	.057	.11	.15
Los Angeles	.....	50.00	....	6.50*b*	15.00	6.50*bg*	15.00*g*	5.50*b*	.....	.0192	.0525	.1125
Minneapolis	.....	.....	1.90*d*	19.20	24.20	.10	.12	19.30	28.30	.056	.....	.....
Montreal	75.00	.....	3.62	14.60	21.25	.105	.137	.101*h*	.121*h*	.07	.135	.185
New Orleans	.....	.....	....	14.00*a*	19.00*a*	.055	.085	.065*h*	.095*h*	.....	.078	.....
New York	.....	.....	2.75	15.00	21.00	.06	.09	.065*h*	.115*h*	.....	.07	.11
Philadelphia	120.00	42.50	2.84	14.00	19.00	.055	.08	.065*h*	.095*h*	.05	.06	.09
Pittsburgh	135.00	38.75	....	.....	.....	.....	.....	.....	.....	.....	.....	.....
St. Louis	110.00/121.00	37.00	....	14.00	19.00	14.00*g*	19.00*g*	.065*h*	.095*h*	.04	.09	.125
San Francisco	.....	70.00	....	6.50	15.00	6.50*g*	15.00*g*	7.00	17.50	.025	.0525	.1125
Seattle	.....	60.00*c*	....	14.70	24.10	.....	24.10*g*	9.50/10.50	23.00/24.00	7.75*g*	.0575*i*	.1308*i*

‡ Delivered. *a* F.o.b. Baton Rouge. *b* Delivered to purchaser's warehouse. *c* 3¼x4x8½ in. *d* 2½ in. 6 to 8-lb. treatment. *e* Local reduction due to 20% reduction intra-state class freight rates, only Georgia affected. *f* Mexican. *g* Per ton. *h* Per gallon. *i* F.o.b. Martinez. *j* 3x3⅝x8½ in.

IRON AND STEEL PRODUCTS—BASE MILL PRICES

	STRUCT. SHAPES-PLATE	REINF. BARS ¼-in. billet *b*	RIVETS ½-in. structural	WIRE NAILS Base *d*	SHEET PILING Base	STEEL RAILS Per Gross Ton: Standard	Light	Re-rolled	TRACK SUPPLIES: Angle Bars	Std. Spikes *c*	Tie Plates *c*	Track Bolts
Birmingham	$2.10	$2.15	$3.40	$2.55	.....	$40.00	$40.00	$39.00	$2.70	$3.00	$2.15	$4.15
Chicago	2.10	2.15	3.40	2.55	$2.40	40.00	40.00	39.00	2.70	3.00	2.15	4.15
Pittsburgh	2.10	2.15	3.40	2.55	2.40	40.00	40.00	39.00	2.70	3.00	2.15	4.15
Buffalo	2.10	2.15	.....	.....	2.40	.....	.....	.....	.....	.....	2.15	.....
Cleveland	2.10	2.15	3.40	2.55	.....	.....	.....	.....	.....	.....	.....	.....
Youngstown	.....	2.15	.....	.....	.....	.....	.....	.....	.....	3.00	.....	.....
Detroit	.....	2.25‡	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Gulf ports	2.45*a*	2.40*a*	.....	.....	2.85*a*	.....	.....	.....	.....	.....	.....	.....
Pacific ports	2.75*a*	2.50*a*	.....	.....	2.95*a*	.....	.....	.....	.....	3.00	2.30	.....

‡ Delivered. *a* F.o.b. cars dock. *b* Rail steel same as billet prices. *c* Other basing points include Portsmouth, O., Weirton, W. Va., St. Louis, Kansas City, Minnequa, Colo., and Pacific coast ports, on tie plates, alone, Steelton, Pa., on spikes alone, Lebanon, Pa., Richmond, Va. *d* Add switching charge $18 per c.l.

IRON AND STEEL PRODUCTS—F.O.B. WAREHOUSE, PER 100 LB., BASE PRICE

	STRUCTURAL SHAPES Per 100 lb. base price	REINFORCING BARS* Per 100 lb., ¼ in., base price: 15 tons or over *b* New billet	Rail steel	Add Switch	$/cwt. for Del.	EXPANDED METAL LATH—Per 100 sq.yd.. carload lots— Std. diamond mesh, 3.4 lb.	Std. ribbed 3.4 lb.	WELDED FABRIC REINFORCING —Per 100 s.f., carload lots— 4x16 in., No. 5 & 10 wires	4x12 in., No. 8 & 12 wires	6x6 in. No. 6 & 6 wires Per sq. yd.	SHEET PILING Per 100 lb. base price
Atlanta	$2.34	$2.39	$2.14	.02½	.10	$21.00	$23.00	$1.82	$1.35	$0.1719	$3.04
Baltimore	3.70	2.90	2.75	.....	.10	24.00	26.00	1.70	1.27	.1611	2.90
Birmingham	2.10*a*	2.15	2.15	.02½	.10	20.50	22.50	1.80	1.34	.1701	....
Boston	3.85	2.61	2.46	$20 C.L.	.10	21.50	23.50	1.76	1.31	.1656	3.14
Chicago	2.10*a*	2.15	2.05	.03	.05	19.50	21.50	1.67	1.25	.1575	2.40
Cincinnati	3.68	2.46*c*	2.36*c*	.....	.05	20.50	22.50	1.66	1.25	.1566	....
Cleveland	3.58*g*	2.15	2.05	.02½	.10	22.50	23.50	1.66	1.25	.1566	....
Dallas	4.75	3.25	3.25	.....	.....	25.00	27.00	1.93	1.42	.1827	....
Denver	4.35	3.95	3.80	.....	.....	23.50	25.50	1.97	1.45	.1863	....
Detroit	3.60‡	2.35	2.20	.....	.10	22.50	24.50	1.68	1.26	.1584	2.66
Kansas City	4.00	2.51*c*	2.36*c*	.0	.05	15.50	19.00	1.78	1.33	.1683	2.86
Los Angeles	3.65*f*	2.25	2.10	.02½	.05	23.00	27.50	1.93	1.42	.1827	3.65
Minneapolis	3.80‡	2.48*c*	2.33*c*	.0	.10	19.50/20.50	21.50/22.50	1.80	1.34	.1701	2.734
Montreal	.....	.....	2.60	.....	.....	26.50	29.00	2.99	2.08	.319	....
New Orleans	4.40	2.52	2.52	.05	.10	21.50	23.50	1.82	1.35	.1719	2.875
New York	3.75	2.39	2.29	.....	.10	14.50	16.50	1.76	1.32	.1665	2.74
Philadelphia	3.55	2.66	2.56	.....	.....	19.50	21.50	1.71	1.28	.1611	2.72
Pittsburgh	2.10*a*	2.15	2.05	.02½	.10	21.50	24.50	1.59	1.20	.1503	2.40
St. Louis	3.47	2.39	2.29	.0	.05	24.00	28.00	1.69	1.27	.1602	2.70
San Francisco	3.35	2.40	2.25	.02½	.10	19.00	25.50	1.93	1.42	.1827	3.25
Seattle	2.75*e*	2.50*e*	.....	.....	.....	25.50	27.50	1.93	1.42	.1827	2.95*e*

‡ Delivered. *a* Mill prices. *b* 5–15 tons, add 15c. 1–5 tons, add 25c. Less than 1 ton, add 50c. *c* 20 tons or over Base. *d* Mill price plus freight. *e* F.o.b. dock. *f* Includes delivery in free delivery zone. *g* Less than 1 ton, add 30c.; 1 to 5 tons, add 10c. High scrap steel prices cut former 15c. differences between new billet and rail steel in many mills.

PLUMBING, HEATING, WATER, SEWER AND DRAIN PIPE

	C. I. PIPE Per net ton f.o.b. 6 in. to 24 in.*a*	VITRIFIED SEWER PIPE Per foot, std. 8 in., e.s.	delivered std. 12 in., e.s.	ASTM 24 in.,	C13–35 36 in.,	CLAY DRAIN TILE Per 1,000 ft., carload lots, f.o.b. 6 in.	8 in.	CONCRETE SEWER PIPE Per ft., delivered; ASTM 12 in.	C 14–35 24 in.	WROUGHT STEEL PIPE Full standard weight, *h* 1 to 3 in., Butt Weld Black %	Galv. %	3½ to 6in.; Lap Weld Black %	Galv. %
Atlanta	$49.40	$0.26*b*	$0.468*b*	$1.8525	$4.68*c*	$85.00	$128.00	$0.45	$1.642	62.2	54.2	59.7	51.2
Baltimore	52.80	.35	.60	2.30	6.80	115.00	150.00	.50	1.75	65.5	57.5	63.00	54.5
Birmingham	45.00	.20	.468	1.7875	4.66	85.00	220.00	.40	1.60	62.2	54.2	59.7	51.2
Boston	55.00	.231	.4455	1.89	5.2275	180.00‡	280.00‡	.50	2.30	64.1	56.1	61.6	53.1
Chicago	53.80	.28	.54	2.25	6.25	100.00‡	150.00‡	.38	1.48	67.0	59.0	63.5	55.0
Cincinnati	52.70	.245	.4995	1.9335	5.6375	105.00	170.00	.60	1.70	65.9	57.9	63.4	54.9
Cleveland	54.24	.196	.378	1.485	4.51	69.00	108.00	.35	1.50	67.8	59.8	65.3	56.8
Dallas	58.20	.28	.504	2.016	4.70	80.00	100.00	.46	1.57	59.9	51.9	57.3	48.3
Denver	60.60	.24†	.52†	2.16†	.....	130.00	240.00	....	....	58.4	50.4	55.7	47.2
Detroit	54.24	.245	.4725	1.935	4.408	66.45	105.00	.33	1.50	66.3	58.3	63.8	55.3
Kansas City	55.12	.30	.54	2.16	5.00	120.00	240.00	.45	1.60	62.9	54.9	60.0	51.5
Los Angeles	55.00	.282†	.508†	2.034†	5.085†	115.50	192.50	1.00	2.00	59.6	51.6	57.0	48.6
Minneapolis	57.20	.24†	.432†	1.728†	4.60†	.....	.....	.70	1.80	64.2	56.2	60.7	52.2
Montreal	60.00	.55	.90	3.68	5.95*e*	135.00‡	260.00‡	.48	1.92	.....	.....	.....	....
New Orleans	51.38	.26	.48	1.69	.....	150.00	220.00	.37	2.10	62.4	54.4	58.8	50.3
New York	52.20	.32	.63	2.52	6.45	.....	.....	.50	1.20	64.9	56.8	62.4	53.9
Philadelphia	50.90	.....	.....	.....	.....	.....	.....	.54	1.80	65.3	57.3	62.8	54.3
Pittsburgh	55.60	.245†	.4725†	1.845†	5.4325	97.80	154.20	.85*g*	2.00*g*	68.5*i*	60.5*i*	66.0*i*	57.5*i*
St. Louis	52.48	.24	.432	1.728	3.96	85.00	170.00	.75*j*	1.80*k*	65.1	57.1	62.0	53.5
San Francisco	55.00	.3275*d*	.5895*d*	2.358	5.895	107.25	178.75	.54	2.50	.....	.....	.....	....
Seattle	55.35	.35	.63	2.52	6.30	72.00	175.00	.35*f*	1.30*f*	.....	.....	.....	....

‡ Delivered. † F.o.b. *a* B. & S. class B and heavier, C/L lots, 200 tons and over Burlington, N.J. (base) $49.00. Gas pipe and class A, $3 per ton additional, 4 in., $3 per ton additional, 30 in. and larger usually $2 per ton less. *b* Double strength. *c* List to dealer. *d* List. *e* 30-inch. *f* Less 5% for cash. *g* Culvert pipe. *h* Discounts from standard list consumers carload prices, except Pittsburgh prices are f.o.b. mill. Base price $200 per net ton. List prices per ft.: ¼ in., 8½c.; ⅜ in., 11½c.; 1 in., 17c.; 2 in., 37c.; 2½ in., 58½c.; 3 in., 76½c.; 4 in., $1.09; 6 in., $1.92. *i* Applies also at Lorain, Ohio, mills. Chicago delivered base is 2½ points less on butt, 1½ on lap. Freight is figured from Pittsburgh, Lorain, O., Chicago Dist. Billing is from point producing lowest ptice at destination. WROUGHT IRON PIPE: Base price and list prices per ft. same as wrought steel pipe. Discount for Pittsburgh base: Butt-weld—1 in. and 1¼ in. black 34, galv. 19; 1½ in. black 38, galv. 21½; 2 in. black 37½, galv. 21. Lapweld—2½ in. to 3½ in. black 31½, galv. 17½ in.; 4½ in. to 8 in. black, 32½ galv. 20. *j* Reinforced; spec. C 76-37. *k* Reinforced; spec. C 75-37.

11 LORAINS

DO THE HEAVY "HOUSEWORK"

ON PITTSBURGH'S HOUSING PROJECT

● Terrace Villages No. 1 and No. 2, being built by the Pittsburgh Housing Authority in conjunction with the Federal Government, are one of the largest housing projects ever undertaken. The two villages comprise a total of 2,653 dwellings, cover 150 acres, and will cost $8,425,329.

Lorain shovels and cranes have done more than their share of the heavy "housework" on the job. Eleven of these units have seen service to date. The 2-yd. "87" shovel shown below was one of several Lorains which dug 3,500,000 yds. (most of it rock) from the tops of two hills. The two Lorain-79's, pictured operating as crane and clamshell, handled a wide variety of general excavation, placed concrete, hoisted steel to the floors and lumber to the roofs.

The predominance of Lorains on this mammoth project reflects the opinion of not one but many contractors. And the wide use to which they have put these machines indicates their confidence in Lorain performance and Center Drive design regardless of type or capacity.

Make it a point to investigate the reasons that have made Lorains the outstanding shovel and crane choice on countless big time jobs. Start now by writing for complete information on the ⅜ to 2½-yard Lorain line.

THE THEW SHOVEL CO.
LORAIN, OHIO

THEW CENTER DRIVE

These 2 Lorains of the Hunkin-Conkey Const. Co. make a total of 10 Lorains for them.

⅜ TO 2½ YD. LORAINS

LUMBER, TIMBER, PLYWOOD—PER M FT., B.M., CARLOAD LOTS F.O.B.

SHORT LEAF YELLOW PINE AND DOUGLAS FIR

All S. L. Y. P. is No. 2 common or better and for No. 1 N. C. Box. (Prices in Bold Face)

All Fir planks No. 2 common. Fir timber is No. 1 common. Lengths up to 20 ft. (Prices in italics)

	1x6 S4S	1x8 S4S	2x4 S4S	2x6 S4S	2x8 S4S	2x10 S4S	3x12 Rgh	6x12 Rgh	12x12 Rgh	LONG LEAF Y. P. Merchantable grade up to 20 ft. 2x12 Rgh	12x12 Rgh	PLYWOOD* Rail freight increment (See note for base price) ⅜"	⅝"
Atlanta	**$30.00**	**$30.00**	**$25.00**	**$26.50**	**$26.50**	**$30.00**	**$32.50**	.....	.....	$45.00	$55.00	$17.25	$21.90
Baltimore	**33.00**[1]	**34.50**	**34.00**	**35.00**	**35.00**	**36.00**	**48.00**	.....	.....	70.00	72.00	17.35	21.15
	35.00	*35.00*	*37.00*	*36.00*	*36.00*	*35.00*	*48.00*	*$48.00*	*$48.00*	.....	.....	.....	.....
Birmingham	**25.50**	**26.00**	**25.00**	**25.00**	**25.50**	**28.00**	**42.00**	**59.00**	**59.00**	.....	.....	16.25	19.85
	30.00	31.00	30.00	29.00	31.00	40.00	60.00	.....	.....	62.00	65.00	.....	.....
Boston	33.00[2]	33.00[2]	36.00[3]	36.00	55.00[4]	60.00[4]	77.00[4]	.....	.....	**77.00**	**77.00**	17.35	21.15
	32.00	*32.00*	*36.00*	*36.00*	*38.00*	*38.00*	*47.00*	*47.00*	*47.00*	.....	.....	.....	.....
Chicago	**34.00**	**34.00**	**32.00**	**32.00**	**32.00**	**34.00**	**50.00**	.....	.....	80.00	90.00	13.80	16.80
	38.00	*38.00*	*38.00*	*39.00*	*39.00*	*40.00*	*43.00*	*42.00*	*42.00*	.....	.....	.....	.....
Cincinnati	**31.50**	**33.00**	**30.50**	**31.00**	**32.00**	**35.00**	**44.50**	.....	.....	53.00	56.00	16.25	19.85
	.....	.....	.....	.....	.....	.....	*46.00*	*46.00*	*46.00*	.....	.....	.....	.....
Cleveland	**37.00**	**38.00**	**38.00**	**36.00**	**34.00**	**40.00**	**47.00**	47.00	47.00	80.00	80.00	16.70	20.40
Dallas *e*	**34.00**	**35.00**	**34.25**	**33.25**	**34.25**	**35.50**	**52.50**	**52.50**	**52.50**	71.00	78.00	13.90	16.95
Denver ‡	44.00[4]	43.00[4]	46.50[4]	45.50[4]	41.00[4]	46.00[4]	48.00[4]	60.00[4]	71.50[4]	.....	.....	9.90	12.05
Detroit	**38.00**	**38.00**	**38.00**	**38.00**	**40.00**	**43.50**	**48.00**	.....	.....	44.50	59.00	16.25	19.85
	.....	.....	.....	.....	.....	*48.00*	*49.00*	*56.00*	*56.00*	.....	.....	.....	.....
Kansas City	**36.00**	**36.00**	**33.50**	**33.00**	**34.00**	**32.00**	**37.00**	.....	.....	60.00	65.00	12.25	14.95
	32.50	*32.50*	*33.50*	*32.75*	*33.75*	*32.50*	*37.00*	*40.00*	*40.00*	.....	.....	.....	.....
Los Angeles *a*	*36.00*	*35.00*	*36.00*	*33.00*	*33.00*	*33.00*	*38.00*	*46.00*	*39.00*	.....	.....	9.35	11.35
Minneapolis ‡*b*	38.00[5]	38.00[5]	.....	.....	.....	.....	.....	.....	.....	.....	.....	12.05	14.70
‡	*40.00*	*41.00*	*38.50*	*37.00*	*37.00*	*39.00*	*44.50*	*53.50*	*53.50*	.....	.....	.....	.....
Montreal †[7]	*34.00*	*36.00*	*32.00*	*34.00*	*36.00*	42.00	45.00	.....	.....	155.00	165.00	.....	.....
	52.00	*54.00*	*52.75*	*55.75*	*57.75*	*60.75*	*52.00*	*52.00*	*52.00*	.....	.....	.....	.....
New Orleans	**24.00**	**25.00**	**25.00**	**24.00**	**24.00**	**25.00**	**46.00**	.....	.....	62.00	69.00	13.90	16.95
	29.00	*29.00*	*32.00*	*33.00*	*35.00*	*34.00*	*36.00*	.....	.....	.....	.....	.....	.....
New York ‡	**43.00**	**44.00**	**40.00**	**42.00**	**42.00**	**43.00**	**46.00**	.....	.....	82.50*f*	85.00*f*	17.35	21.15
‡	.....	.....	*47.00*	*47.00*	*47.00*	*47.00*	*47.00*	*51.00*	*51.00*	.....	.....	.....	.....
Philadelphia	**24.00**	**24.50**	**25.50**	**25.50**	**27.50**	**27.50**	**29.00**	.....	.....	50.00	57.50	17.35	1512
	35.00	*36.50*	*39.00*	*38.25*	*29.00*	*39.00*	*44.00*	*32.00*	*32.00*	.....	.....	.....	.....
Pittsburgh	**38.10**	**39.90**	**47.05**	**42.00**	**45.65**	**46.90**	**59.70**	.....	.....	.....	.....	17.00	20.70
	51.90	*49.60*	*49.60*	*49.00*	*48.90*	*49.25*	*66.55*	*66.55*	*66.55*	.....	.....	.....	.....
St. Louis ‡*c*	**41.00**	**41.00**	**37.00**	**36.00**	**37.00**	**38.00**	**49.00**	*57.00*	*57.00*	75.00	74.00	13.90	16.95
San Francisco *d*	*23.50*	*23.00*	*23.00*	*22.50*	*22.00*	*22.00*	*23.50*	*23.50*	*23.50*	.....	.....	7.30*g*	8.90*g*
Seattle	*21.00*	*21.00*	*21.00*	*21.00*	*21.00*	*21.00*	*26.00*	*26.00*	*26.00*	.....	.....	0.00	0.00

Bold Face type, Southern Pine. *Italics, Douglas Fir.* [1] Long leaf. [2] Roofers' N. C. Pine. [3] Spruce. [4] Native. [5] Western Pine, No. 3 Common. [7] Spruce. [6] Norway Pine. ‡ Delivered. *a* Yard prices. *b* Contractors discount in Minneapolis and St. Paul discontinued May 21, 1938. *c* 5M ft. or less. *d* At ship's tackle. *e* 10% discount taken off. *f* Up to 18 ft. † Montreal prices stabilised for balance of year by order of Dominion Controller of Lumber.

NOTE: Special concrete form grade Fir Plywood, 4' by 8' panels, 5-ply, sanded 2 sides, water resistant glue, carload lots, delivered per 1,000 sq. ft. surface. Seattle base price on ⅜", $77.00; on ¾", $84.80; price includes oiling and sealing charges. For other centers add rail freight increment from table or proper size. For resin dipped treatment, add $10.50 per M. *Many mills out of market due to rush of defense orders. *g* Lower rate by water shipment. *h* 50,000 lb. minimum

GLASS, EXPLOSIVES, CHEMICALS

	WINDOW GLASS Discounts from jobbers list, Aug. 15, 1938 Single or Double Thickness A quality	B quality	EXPLOSIVES Per lb. 40% Ammonia Gelatin in 50-lb. cases delivered in 200 lb. lots*
Atlanta	75%	75%	$0.15
Baltimore	83%	82%	.15
Birmingham	75%	75%	.105
Boston	82%	82%	.15
Chicago	79%	79%	.15
Cincinnati	77%	77%	.15
Cleveland	79–10–10%	79–10–10%	.205
Dallas	78%	78%	.165
Denver	77%	77%	.15*e*
Detroit	79–10%	79–10%	.15
Kansas City	77–10%	77–10%	.165
Los Angeles	86%*d*	88%*d*	.1575
Minneapolis	76%	76%	.16
Montreal	.....	.....	.17†
New Orleans	70%	75%	.16
New York	81%	82%	.22*f*
Philadelphia	82–10%*d*	83–10%*d*	.15
Pittsburgh	79%	79%	.1425
St. Louis	77–10%	77–10%	.155
San Francisco	78%*d*	83%*d*	.155
Seattle	85%*d*	88%*d*	.1575

Price of 60% Ammonia Gelatin is $0.015 per lb. higher than 40%

a Disc. from list Sept. 1939. *b* Also less 6% tax exemption. *d* Discount from jobbers' list Sept. 15, 1928.

* Urban prices influenced by service charges or local storage and delivery regulations, do not consistently reflect quantity prices in less congested areas. *e* F.o.b. Louviers, Colo. In boroughs of Kings, Queens and Richmond, and in Manhattan south of Canal Street, add delivery charge of $6.00 per trip. † F.o.b.

40% Ammonia Gelatin price ranges in other than urban areas, per lb. (except Seismograph Grades)

	C/L 20,000 lb. net	Tons	200 lb. lots
E. of the Miss., except Fla	$0.105	$0.14	$0.16
W. of Miss. to Rocky Mtn. States, and Fla	.11 –.12	.135 –.15	.155 –.17
Rocky Mtn. States	.11 –.1325	.13 –.145**	.15 –.165**
Pacific N. W. States	.1075–.115	.1375–.15	.1575–.17
Pacific S. W. States	.1050–.1175	.135 –.1475	.155 –.1625

** F.o.b. Louviers, Colo., or Butte, Mont.

PILES, TIES—F.O.B.

PILES

Prices per linear foot, pine, with bark on, f.o.b. New York; delivered from barge 1¼ to 2c. per ft. additional:

Dimensions	Points	Length	Short Leaf Barge	Short Leaf Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.18	$0.195
12 in.— 2 ft. from butt	6 in.	50 to 59 ft.	.225	.24
12 in.— 2 ft. from butt	6 in.	60 to 69 ft.	.23	.255
14 in.— 2 ft. from butt	6 in.	50 to 69 ft.	.24	.265
14 in.— 2 ft. from butt	6 in.	70 to 79 ft.	.28	.275
14 in.— 2 ft. from butt	5 in.	80 to 85 ft.	.40	.415
14 in.— 2 ft. from butt	5 in.	85 to 89 ft.	.42	.482

RAILWAY TIES

Prices f.o.b., per tie for carload lots:		6"x8"x8' Untr.	6"x8"x8' Tr.	7"x9"x8'6" Untr.	7"x9"x8'6" Tr.
Boston	Oak	$1.20	....	$1.65	....
	Pine	1.50	$2.25*a*	2.25	$3.20*a*
New York	S. L. Sap Pine	1.10/1.20	1.85	1.50	2.35
	Mixed Oak	1.45	1.95	1.90	2.45
Birmingham	White Oak	.85	1.50*a*	1.35	1.70*a*
	Southern Pine	.55*b*	1.10*a b*	.70	1.30*a*
Chicago	Oak	....	1.65*a*	....	2.27*a*
	Southern Pine	....	1.53*a*	....	2.13*a*
Los Angeles	Douglas Fir	.64	1.38*a*	.90	1.80*a*
Philadelphia	Red Oak	1.10	....	....	2.40*a*
St. Louis	White Oak	1.12	....	1.50	....
	Red Oak	1.12	1.60*a*	1.50	2.05*g*
	Sap Pine or Cypress	1.02	....	1.40	....
San Francisco	Douglas Fir	.90*e f*	....	....	1.95*e f*
Montreal	Birch or Maple	.65	1.05*a*	.75	1.35*a*

Tr.— Treated; Untr.— Untreated. *a* Creosoted. *b* 6" x 8" x 8'6". *c* Empty cell. *d* Zinc. *e* Green. *f* At ships tackle.

CHEMICALS

Water, sewage treatment, road work, f.o.b. carlots, New York

Bleaching powder, in drums, f.o.b. works, per 100-lb	$2.00–2.85
Chlorine cylinders, liquid, per lb. delivered	0625
Calcium chloride, 77–80%, flaked, in 400-lb. drums or 100-lb. moisture proof bags, delivered, per ton	20.50–35.00
Silicate of soda, 52 deg., in drums, f.o.b. works, per 100 lb	1.40
Soda ash, 58%, in paper bags, per 100 lb. dense	1.10
Sulphate of aluminum, commercial, in 100-lb. bags, per ton	23.00
Sulphate of copper, in bbl., per 100-lb	4.75

SPEED

2000 Monotubes

Produced,
Delivered and Driven in

14 Days!

● More evidence to prove that Monotubes can speed up foundation jobs to a new high. The job in question was a large plant addition for a prominent automotive concern, and called for the installation of approximately 2,000 cast-in-place concrete piles 14 days from date of contract.

The order for 2,000 Monotube *steel* casings in 20, 23, 25 and 28 ft. lengths was received on January 26th. Production began on the 27th and shipments started on the 28th. The contractor began driving operations on January 30th, using two rigs full time and a third rig intermittently. On February 8th, which was the 14th day after receipt of order, all but a few odd piles were driven and the finishing touches were completed the following day.

The Monotube Method of Pile Construction cuts away costly and time-consuming red tape. These cold rolled tapered *steel* casings are light in weight for fast, economical handling. They drive faster because they require no core or mandrel. Installation can be made by any experienced contractor with a crawler crane (which is usually already on the job), standard leads and hammer. The casings can be inspected thoroughly after driving and, when filled with concrete, produce piles of proven strength and durability.

Union Metal offers you Monotubes in a gauge, taper and length to meet every soil condition—plus the free services of experienced foundation engineers. Write for copy of Catalog No. 68A. It tells you how and why Monotubes speed up foundation jobs with safety.

UNION METAL

THE UNION METAL MANUFACTURING CO.
CANTON, OHIO

STRUCTURAL CLAY BUILDING TILE, BRICK AND LIME—DELIVERED

	STRUCTURAL CLAY TILE — PARTITION — SCORED			STRUCTURAL CLAY TILE — LOAD BEARING — SCORED			BRICK		LIME		
	Per M. lots of 2,000 pieces or over,			Per M. lots of 2,000 pieces or over,			Per M. in quantity.		Per ton,	In paper,	carload lots, Universal or Lump
	3x12x12 in.	4x12x12 in.	8x12x12 in.	8x12x12 in.	10x12x12 in.	12x12x12 in.	Common backing	Straight hard	Hydrated finishing	Common hydrated	
Atlanta	$90.00	$100.00	$185.00	$220.00	$230.00	$240.00	$12.50	$16.00	$26.50	$17.00	$17.00
Baltimore	75.00	80.00	150.00	180.00	225.00	280.00	14.00*c*	17.00*c*	18.50	14.50	2.70*m*
Birmingham	80.00	85.00	160.00	191.00	252.00	288.00	13.50	16.50	17.11	11.64	1.75*n*
Boston	95.05*a*	101.40*a*	190.05*a*	215.35	279.20*a*	319.10*a*	17.00*i*	20.00*i*	21.00	14.00	18.00
Chicago	68.10	72.60	135.90	185.70	234.90	268.10	11.00	12.00	16.40	14.40	12.20
Cincinnati	61.40	65.30	121.90	141.50	187.30	215.20	16.00	16.00	15.90	13.00	
Cleveland	56.50	60.00	112.50	135.00	182.50	209.00	16.00	16.00	15.00*j*	12.00*j*	2.75*m*
Dallas	62.50	67.00	135.00	162.00	177.00	263.00	11.50*i*	13.50*i*	19.00	15.00	95*n*
Denver	84.80	95.40	152.70	178.20	212.00	227.90	13.50	17.00	28.00*j*	17.00*j*	35.00*p*
Detroit	68.90	73.50	137.80	175.50	232.00	265.00*e*	15.70	17.00	13.50	11.75	12.75
Kansas City	64.50	66.50	86.00*c*	125.50	159.75	186.25	14.25	24.00	19.10	12.80	10.70
Los Angeles	73.50†*r*	89.50†*r*	128.00*c*†*r*	210.00†*r*	368.00†*r*	460.00†*r*	13.50	15.00	16.50	.....	17.50
Minneapolis	71.45	76.20	143.95	171.45	173.80	242.10	13.10	15.10*g*	21.00	16.00	19.00
Montreal	72.20*a*	77.50*a*	142.50*a*	76.00*at*	165.80*a*	248.70	20.75	28.00	23.50	17.00	12.00
New Orleans	72.00	72.00	135.00	162.00	210.00	260.00	14.00	.....	18.30	12.08	14.10
New York	87.00	93.00	128.00*c*	193.30*h*	238.80*h*	295.60*h*	13.00	.....	19.00	14.00	17.00
Philadelphia	80.50	85.90	161.10	193.30	238.80	295.60	15.50*a*	18.00*a*	15.50*q*	9.55*q*	12.05*q*
Pittsburgh	58.40	62.40	116.85	124.00	153.00	193.75	17.00	25.00	17.90	15.40	2.55*m*
St. Louis	62.00	88.00	120.00	180.00	234.00	280.00	16.00	17.00	22.00	16.00	2.30*m*
San Francisco	84.00	94.50	225.00	.....	.....	.....	14.00	17.00	.55*o*	.40*o*	2.05*m*
Seattle	100.00	110.00	220.00	.....	.....	.....	17.50*f*	17.50*f*	20.00*s*	20.00*s*	20.00*s*

† F.o.b. *a* Smooth. *b* Carload lots delivered to job. *c* 6x12x12 in. *d* Not load bearing. *e* 48 lb. tile. *f* Less $1.00, ½ cash 15 days, balance 30 days. *g* Selected common. *h* F.o.b. Perth Amboy, N. J. *i* 50c. per M. off for cash. *j* LCL. *k* $1.00 discount if paid in 10 days. *l* Lump. *m* Per bbl., 180 lb. *n* Per sack 100 lb. *o* Per bbl., 200 lb. *p* 280 lb. bag. *q* 25-ton cars. *r* 5% discount 10 days. *s* 2% off cash. *t* 5½ x 8 x 12.

PAINT, ROOFING—F.O.B. CARLOAD LOTS

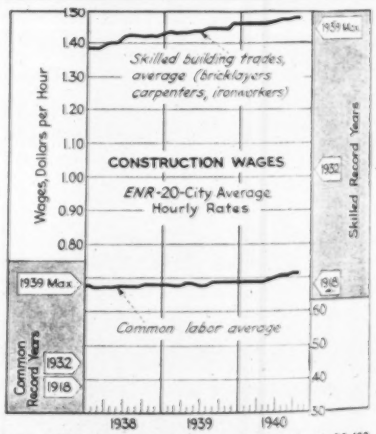
	RED LEAD	WHITE LEAD	READY-MIXED PAINT			ROOFING SUPPLIES Carload lots f.o.b. factory				
	Per 100 lb. in 600-lb. (Approx.) bbl. Dry *a*	Per 100 lb. in oil	Per gal., drums Graphite *b*	Aluminum *c*	Ferric Oxide *d*	Rolls, slate surfaced, 85-90 lb. per sq.	Asphalt felt, per 100 lb.	Tar felt, per 100 lb.	Asphalt coating per gal.	Tar pitch 350 lb. bbl. per ton
Atlanta	$8.75	$13.125	$1.30	$2.25	$1.20	$1.90	$1.61	$1.61	$0.27	$29.00
Baltimore	8.50	12.75	1.75	2.50	2.00	2.25	2.85	2.85	.50	27.50
Birmingham	8.75	13.125	2.35	2.75	1.85	1.98	1.57	1.57	.32	27.00
Boston	8.50	12.75	1.80‡	2.40‡	1.75‡	1.75‡	1.85*h*‡	1.85*h*‡	.50‡	30.00‡
Chicago	8.50	12.75	1.96	2.63	1.68	1.45*h*/*f*	1.50*h*/*f*	1.50*h*/*f*	.25/*f*	21.00/*f*
Cincinnati	8.50	12.75	1.65	2.85	1.55	2.40	2.39*h*	2.39*h*	.36	21.00
Cleveland	8.50	12.75	1.90	2.60	1.60	1.75	1.50*h*	1.50*h*	.35	21.00
Dallas	8.50	13.50	1.88	2.11	....	2.75*h*	2.60*h*	2.70*h*	.275	31.00
Denver	9.00	13.25	1.65	2.40	.17*l*	2.45	4.00	3.00	.35	18.00
Detroit	8.50	12.75	1.75	2.75	1.25	2.40	2.50	2.50	.35	26.00
Kansas City	8.50	12.875	2.15*g*	2.40*g*	1.67*g*	1.93	2.09	2.09	.25	25.00
Los Angeles	8.75	13.25	1.60	2.25	2.30	2.10	1.50	....	.45	.....
Minneapolis	8.50	12.875	....	....	....	1.75*i*	1.50*h*/*i*	1.50*h*/*i*	.29	21.00
Montreal	9.25	9.00	2.25	2.80	2.35	2.53	1.68	1.78	.70	1.68*k*
New York	8.50	12.75	1.88	2.55	1.60	1.75	1.50*h*	1.50*h*	.23	24.00
Philadelphia	8.50	12.75	....	....	....	1.92*e*	1.99*h*/*e*	1.99*h*/*e*	.41*e*	21.00
Pittsburgh	8.50	12.75	1.05	1.95	.80	1.95	1.94*h*	1.94*h*	.34	26.00
St. Louis	8.50	12.75	1.90/2.00	2.60/2.85	1.60/2.00	2.04	1.50	1.50	.24	21.00
San Francisco	8.75	13.00	1.80	2.75	1.10/2.00	1.65	2.26	2.26	.28	17.00
Seattle	8.75	13.25	1.80	2.60	....	1.81	1.30/2.00	1.75	.35	28.00*j*

‡ Delivered. Note: Red lead in oil 50c. higher than white lead in oil. *a* Red lead prices change frequently due to pig lead price changes. *b* U. S. War Dept. Spec. 3-49A. *c* ASTM Spec. D266-31. *d* 80% minimum ferric oxide. *e* Subject to 25% discount. *f* Distributors' price to contractors. *g* 5 gal. can. *h* Per roll, 65 lb. *i* Minneapolis and vicinity. *j* Asphalt pitch. *k* Per 100 lb. *l* Per lb.

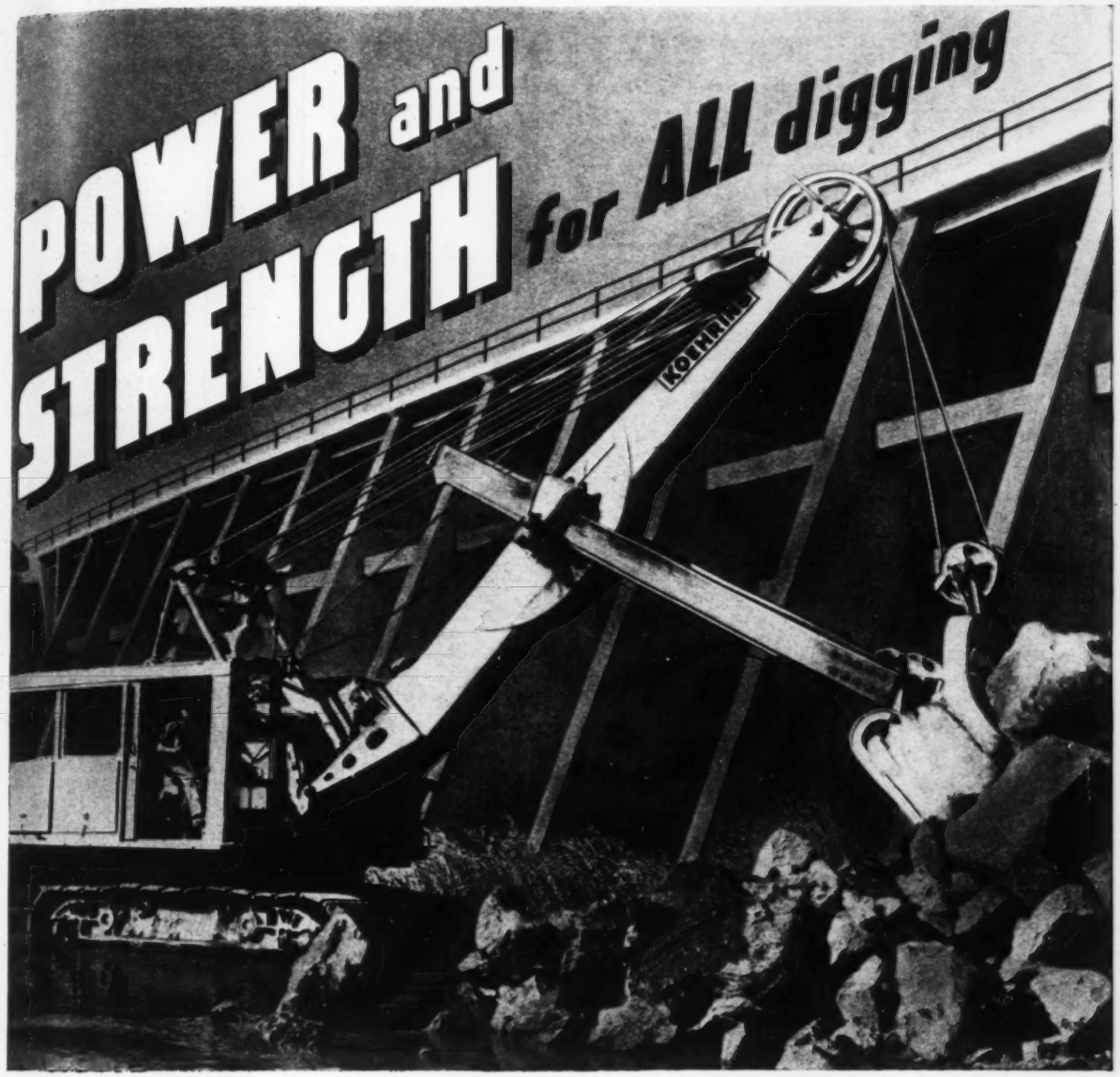
SKILLED AND COMMON WAGE RATES—PER HOUR

	Bricklayers	Carpenters	Struct. Iron Workers	Hoisting Engineers	Plasterers	Common Labor—Building	Common Labor—Heavy Const.
Atlanta	$1.25	$1.00	$1.375	$1.00/1.25	$1.25	$0.40/.50	$0.40/.50
Baltimore	1.50	1.25	1.65	1.50	1.375	.625	.625
Birmingham	1.50	1.125	1.375	1.125	1.00	.40	.40
Boston	1.50	1.375	1.625	1.375/1.625	1.625	.60/.85	.60/.85
Chicago	1.70	1.625	1.70	1.70	1.70	1.025	1.025
Cincinnati	1.625	1.45	1.55	1.375/1.525	1.625	.75	.75
Cleveland	1.625	1.375	1.50	1.50/1.75	1.50	.90	.90
Dallas	1.50	1.00	1.25	1.00	1.50	.40/.50	.40/.50
Denver	1.65*b*	1.43*b*	1.43*b*	1.43*b*	1.50*b*	.718*b*	.718*b*
Detroit	1.50	1.25	1.625	1.50	1.55	.60/.75	.60/.775
Kansas City	1.625	1.375	1.50	1.50	1.575	.85	.50
Los Angeles	1.25	1.10	1.375	1.375	1.50	.625	.625
Minneapolis	1.375	1.25*d*	1.50	1.40	1.50*e*	.85	.85
New Orleans	1.50	1.25	1.375	1.375	1.40	.40	.50
New York	2.00*b*	1.85*b*	2.00	2.00*b*	2.00*c*	1.031	.875/.95
Philadelphia	1.65*b*	1.40	1.65	1.50	1.75	.70	.70
Pittsburgh	1.75	1.50	1.50	1.25	1.75	.80	.70
St. Louis	1.50	1.50	1.75	1.50/2.00	1.75	.45/.875	.875
San Francisco	1.75*c*	1.25	1.60	1.50	1.60*c*	.813	.813
Seattle	1.60	1.25	1.50	1.50	1.60	.90	.90
Montreal	.80	.70	.75	.65	.80	.45	.40

b 7 hr. day. *c* 6 hr. day *d* 35 hr. wk. *e* 30 hr. wk.



ENR Skilled Average: (Bricklayers, Carpenters, Ironworkers) **$1.480**
ENR Common Average: $0.711



KOEHRING POWER — built into the shovel from engine to clutches, gears, and crowd—power that flows without loss or interruption to the digging dipper — is the "stuff" that counts to maintain high speed maximum production on day and night working schedules.

KOEHRING STRENGTH — built into the shovel to "take" the power — strength without a weak link — Heavy-Duty construction—from crawlers to dipper—is the quality required for high speed digging in all types of material. Dirt or rock, Koehring strength is digging strength.

Koehring equipment is noted for its quality and honest workmanship. Profits are made from working, not buying a shovel. Buy Koehring for working qualities and profit.

KOEHRING COMPANY MILWAUKEE, WISCONSIN

KOEHRING HEAVY DUTY

HEAVY-DUTY CONSTRUCTION EQUIPMENT

CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

TUNNEL REHABILITATION PITTSBURGH, PA.

OWNER: Board of Commissioners, Allegheny County, Pa.; Levi Burd Duff, engineer.

PROJECT: Rehabilitation of McKees Rocks-West Park Tunnel connecting Tunnel Way with Ridge Ave. in Stowe Township, Pittsburgh, Pa. Includes removal of masonry in tunnel lining; placing of new lining including steel ribs and reinforcement; drainage features between new and existing lining, and connection to new drainage system; extension of tunnel at East end; new portals and retaining walls at each end; attachment of new work to old; new roadway pavement, sidewalks and railings; underground drainage system with all accessories; all shoring, centering, lagging, sheet piling and bracing; and all excavation, grading and disposal of surplus material.

CONDITIONS: Contractor to furnish all materials and complete work in 270 working days. Highway transportation facilities available at site of work. Wage rates specified are: skilled labor, $1.50 to $1.75 per hr.; semi-skilled, $1.00 to $1.50; and common labor, 70c. per hr.

BIDS: Nine bids were received August 6, 1940, ranging from the contract low of $153,979 to $268,885.

LIST OF BIDDERS:

1. Mike Manella, Pittsburgh, Pa. (contract) $153,979
2. John F. Casey Co., Pittsburgh, Pa. 168,198
3. Edward Kean, Pittsburgh, Pa. 168,522
4. Booth & Flinn, Pittsburgh, Pa. 177,559
5. Harrison Constr. Co., Pittsburgh, Pa. 178,210
6. H. B. Jacobs, Pittsburgh, Pa. 186,836
7. George Vang, Inc., Pittsburgh, Pa. 189,941
8. W. F. Trimble, Pittsburgh, Pa. 194,342
9. Middle West Constr. Co., Pittsburgh, Pa 268,885

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Excavation, Class 1	4,500 c. y.	$1.00	$1.90	$1.00
2. Excavation, Class 2	1,600 c. y.	3.00	3.40	2.00
3. Remove, dispose of undisclosed undergr. struct. of brick, conc., or stone masonry	10 c. y.	5.00	5.00	5.00
4. Gran. slag behind portals and tunnel exten.	700 c. y.	1.00	2.00	1.00
5. Class A conc., tunnel ext., portals, etc.	400 c. y.	20.00	25.00	26.00
6. Class A-M conc., tunnel lining, membr. waterprfg., flashing, etc.	1,300 c. y.	29.00	37.00	38.00
7. Class B conc., ret. walls, fndn., etc.	800 c. y.	17.00	17.50	30.00
8. Concrete, sidewalk on grade	9,400 s. f.	.30	.40	.30
9. Class P. conc., 1-course r. c. pavement, 10- x 8- x 10-in.	2,100 s. y.	3.00	3.75	3.50
10. Conc. curb (white) with underdrain and 6-in. perf. clay pipe	600 l. f.	1.50	2.85	2.25
11. Conc. curb (white) spec.	1,050 l. f.	1.50	3.05	2.00
12. Conc., center strip (white)	650 l. f.	.75	1.70	1.25
13. Spec. storm inlet, Cl. A-M conc., incl. rein. and excav.	25 c. y.	20.00	30.00	40.00
14. Conc. Class A gutters	80 l. f.	2.50	3.00	3.00
15. Membrane waterproofing	200 s. y.	2.00	2.85	1.50
16. 10-in. c. i. pipe culv., incl. spec.	72 l. f.	4.00	6.00	2.50
17. 12-in. rein. conc. pipe culv.	80 l. f.	2.50	3.00	2.50
18. 15-in. rein. conc. pipe culv.	140 l. f.	4.00	3.60	3.00
19. 6-in. clay pipe culvert	140 l. f.	1.50	1.00	1.25
20. 8-in. clay pipe culvert	80 l. f.	2.00	1.50	2.00
21. 36-in. clay pipe culvert	72 l. f.	9.00	12.00	7.00
22. Brick catchbasins, type 1 and 1A	3 ea.	125.00	350.00	110.00
23. Brick catchbasin, type 6	1 ea.	100.00	300.00	110.00
24. Brick storm inlet, type 2	1 ea.	100.00	275.00	100.00
25. Brick manhole	4 ea.	125.00	160.00	80.00
26. Spec. conc. manhole	3 ea.	150.00	275.00	100.00
27. Lower manhole and build new frame and cover	1 ea.	25.00	75.00	50.00
28. 6-in. perf. clay pipe, puddled clay	1,200 l. f.	1.00	.75	.60
29. Underdrain, spec. beneath sidewalks and duct M	450 c. y.	3.00	4.20	9.00
30. Spec. concrete vault	1 ea.	100.00	50.00	80.00
31. Medium carbon steel, in place	330,000 lb.	.07	.07	.055
32. Copper, in place	2,000 lb.	.70	.60	.60
33. Drainage duct L	150 l. f.	3.00	5.00	7.00
34. Drainage duct M	300 l. f.	4.00	1.50	9.00
35. Drainage duct N	1,350 l. f.	5.00	2.00	5.00
36. C. I. frame and cover castings, No. 14 and 15	2 sets	30.00	40.00	50.00
37. Name plate, in place	2 ea.	150.00	110.00	*75.00
38. Steel reinf. bars and mesh	180,000 lb.	.05	.055	.05
39. Railing	1,000 l. f.	3.50	4.50	4.00
40. Sheeting, shoring and bracing, left in place	5 Mbm.	20.00	20.00	20.00
41. Steel sheet piling, left in place	4,000 s. f.	1.00	.25	1.00
42. Oak lumber, left in place	4 Mbm.	80.00	100.00	25.00
43. Contractor's tools, plant, equip. and overhead	L. S.	15,000.00	7,900.00	8,000.00

HIGHWAYS, NEW MEXICO

OWNER: New Mexico State Highway Department, Santa Fe, N.M.; F. D. Hawley, Springer, N.M., district engineer.

PROJECT: Grading, minor drainage structures, concrete box culverts, one triple 50-ft. span concrete and steel bridge, and miscellaneous construction in connection with improvements to 7.690 miles of Romeroville-Tecolote Road (U.S. 85) in San Miguel County, New Mexico.

CONDITIONS: Contractor to furnish all materials and complete work in 200 weather working days. Minimum wages specified are: skilled labor, 90c. to $1.50 per hr.; semi-skilled, 60 to 80c.; and common labor, 40 to 55c. per hr.

BIDS: Seven bids were opened September 13, 1940, ranging from the contract low of $187,258 to $242,276. This bid was for use of concrete pipe. Engineer's estimate on this basis was $192,346. Using corrugated galvanized metal culvert pipe the bids ranged from $187,285 to $240,624. Engineer's estimate, $192,346.

LIST OF BIDDERS: (On alternate which award was made.)

1. W. T. Bookout, Las Vegas, N.M. (contract) $187,258
2. Skousen Bros., Albuquerque, N.M. (metal pipe) 195,420
3. DeRemer & Atchison, Littleton, Colo. 199,264
4. Sanders Bros., Santa Fe, N.M. 200,580
5. F. D. Shufflebarger, Albuquerque, N.M. 214,277
6. Brown Brothers, Albuquerque, N.M. 221,931
7. L. R. Allison, Albuquerque, N.M. 242,276

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Remove old drainage struct.	L.S.	$955.00	$500.00	$500.00
2. Remove obstructions	L.S.	250.00	300.00	300.00
3. Unclassified excavation	252,861 c. y.	.30	.30	.35
4. Excavation for structures	2,136 c. y.	2.00	2.00	1.50
5. Excav. for pipe culverts	686 c. y.	1.00	1.00	1.00
6. Overhaul	538,567 sta. y.	.01	.01	.01
7. Haul	175,315 y. m.	.045	.04	.03
8. Finish earth graded road	406 sta. y.	2.00	3.00	5.00
9. Cl. A conc., box culverts	1,906.8 c. y.	14.80	17.50	17.00
10. Cl. B conc., pipe culv. headwalls	16 c. y.	14.80	20.00	17.00
11. Reinforcing steel	332,760 lb.	.04	.043	.043
12. Mortar rubble masonry	204 c. y.	11.00	13.00	12.50
13. Rock fill, bank protection	543 c. y.	1.00	.90	1.00
14. Wire fabric, blanket bank prot.	27,706 s. f.	.055	.05	.05
15. Cedar posts, bank protection	182 l. f.	.20	1.00	.25
16. Conc. blanket bank protection	483 s. y.	2.80	2.50	2.50
17. Gate and cattle guard, 9-ft. rdwy.	4 ea.	225.00	300.00	300.00
18. Rein. cc ne. monument and marker	3 ea.	20.00	25.00	25.00
19. Galv. br rbed wire fence	74,381 l. f.	.065	.06	.05
20. Gates, Texas type	38 ea.	3.50	5.00	3.00
21. Bracing	220 ea.	2.00	1.25	2.00
22. Rt.-of-way and station markers	65 ea.	3.00	3.00	3.00
23. Contour ditches	11,100 l. f.	.02	.05	.03
24. Rock and wire check dam	193 c. y.	6.00	6.00	6.00
25. Watering	1,606 M gal.	3.00	.50	2.50
26. Rolling	795 hr.	4.00	1.50	3.50
27. Cushion material	3,960 c. y.	.40	1.00	.25
28. Flagstone walk	2,185 s. y.	.50	.60	.20
29. Excavation for bridge struct.	735 c. y.	3.50	7.00	2.00
30. Cl. A concrete, substruct.	422.39 c. y.	17.00	20.00	18.00
31. Cl. A concrete, superstruct.	138.6 c. y.	18.00	20.00	18.00
32. Untr. timber, substructure	.208 Mbm.	100.00	100.00	100.00
33. Structural steel	123,171 lb.	.058	.057	.06
34a. Corr. galv. met. culv. pipe, 24-in.	566 l. f.*	2.40	3.50	2.50
35a. Corr. galv. met. culv. pipe, 30-in.	528 l. f.*	2.90	4.20	3.00
36a. Corr. galv. met. culv. pipe, 36-in.	558 l. f.*	5.00	5.90	4.50
34b. Std. rein. conc. pipe, 24-in.	566 l. f.*	2.45	....	2.40
35b. Std. rein. conc. pipe, 30-in.	528 l. f.*	2.90	....	2.90
36b. Std. rein. conc. pipe, 36-in.	558 l. f.*	4.90	....	4.40

* Alternate bids taken on concrete and corrugated metal pipe. Award on former.

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